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‡ indicates communication.
† indicates a short non-illustrated article or note

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THE PAGE NUMBERS FOR THE DIFFERENT MONTHS OF THE YEAR 1910 ARE AS FOLLOWS:

LOCOMOTIVE TERMINALS.

A DISCUSSION OF THE ARRANGEMENT, DESIGN, CONSTRUCTION AND OPERATION OF LOCOMOTIVE TERMINAL FACILITIES TO OBTAIN THE GREATEST EFFICIENCY.

Introduction.

The efficiency of the motive power department is generally determined, first, by the average percentage of the total number of locomotives owned that are ready for the use of the transportation department; second, by the number of engine failures; and third, by the cost of locomotive repairs and maintenance.

In an attempt to improve any or all of these features it will be found that the problem divides itself into four general parts: (1) The design of the locomotive; (2) repair shops; (3) engine houses, and (4) operation on the road. Of these, the first is usually beyond control as far as immediate results are concerned, but the other three are capable of showing quick returns if carefully analyzed.

It is the purpose of this series of articles to discuss in all its details the third factor, *i. e.,* locomotive terminals. It is this point that is very largely responsible for engine failures and the cost of maintenance, and it is principally responsible, so far as the motive power department is concerned, for the percentage of time that the locomotives in service are ready for the use of the transportation department. Careful study of the many operations and arrangements at the different division points will probably result in a greater immediate improvement in the general efficiency than would be possible in any other way. The others are important — very important — but the design and condition of the division terminals is usually the weakest feature on most roads.

SYNOPSIS.

Part I.

General Conditions.

There are probably no two locomotive terminals in the country, even those on the same road and on the same division, that present exactly the same problems in all respects and, taking the country as a whole, the conditions are so different in various sections as to make it the height of folly to erect structures and adopt methods in California or Georgia that would be perfectly suited to the conditions in Montana or Maine. The colder climates complicate the problem and warmer climates simplify it greatly.

Another feature that influences the decision as to the way to obtain the best results is a fairly accurate idea of the number of locomotives to be handled per day and the class of service in which they are engaged. A terminal that turns 200 locomotives in 24 hours, practically all freight, would of course not be well suited for turning 25 engines in mixed service; not only would the size of the house be different, but the organization of the forces and the methods of doing the work would be altered.

Class of traffic on the road and the methods of despatching have a decided influence on the best methods of handling a locomotive terminal. The grade of water used for boilers on a division sometimes makes a very great difference in the scheme of operation. If boilers have to be washed every seven days a type of engine house differing in detail as well as different methods will be required than when boilers are washed once in 30 days and then only to comply with the law. Assigned or pooled locomotives influence the problem; labor conditions in the vicinity, the cost of ground and shape of the plot also have to be taken into serious consideration.

All of these varying conditions and others, such as distance to the main repair shop and quality of the fuel, which will readily suggest themselves, make it impossible to say that any one kind of structure or any particular way of doing the work or of organizing the force is universally the best.

General Principles.

In spite of the various conditions mentioned above it is possible to formulate some general rules that are applicable in every case. Their application may and should differ at different points, but the rules themselves can be accepted as sound.

In the first place, the basis of efficiency of a locomotive terminal is *time* and everything should be considered with the idea of arranging for the shortest possible number of minutes between uncoupling the engine from its train and coupling it on again. This, as far as the mechanical department on most roads is concerned, means the shortest interval from crossing the switches to go to the coal chute to the time it is ready to again go to the yard.

To obtain the best results in saving time between the yard switches and the turntable it is desirable that any locomotive stand still at any one point the minimum length of time to complete any single operation. The clinker pit will probably require the maximum period of delay on any individual locomotive, but if it is of sufficient size and a sufficient force is employed the average time at this point per locomotive can be brought to a very reasonable figure, probably not more than the average delay at other points, such as coal chute or stand pipe. If this is not the case, then there is no objection to delaying the locomotives at other points for the same length of time. If, assuming that locomotives are coaled singly, it takes between three and five minutes to locate the engine under the chute and take on coal, the average delay at any other point should not be greater than this, which, of course, means that the cinder pit and the force operating it shall be large enough to take care of sufficient engines at one time to permit the average delay at this point to equal that at the coal chute. Where several are coaled at once then the average time will probably be less than would be practical at the cinder or inspection pit and sand and water could be taken at the same stop. It is not usually advisable, however, to perform these three operations at one stop.

After entering the house the same time basis will still apply and every necessary operation should be arranged to be performed as quickly as possible consistent with good work. At points where poor boiler water has to be used and it is necessary to wash out at fairly frequent intervals this operation will probably be the longest single one that is customarily performed and it is practically compulsory in such cases to provide a blowing down system of a capacity to empty a boiler with steam at 180 lbs. pressure in not more than 30 minutes; also to provide water for washing out with a pressure of at least 100 lbs. and a temperature of about 150 degs. Provision for then filling the boiler with water at a temperature of 190 degrees and a supply of steam for use if desired, with at least 100 lbs. pressure, will be found to be of great advantage. When appliances of this kind are provided and an efficient fire kindler is used it should be possible to bring an engine in, thoroughly wash the boiler and have it again on the turntable with a good fire and 100 lbs. of steam in not to exceed two hours under normal conditions.

Other general principles that are applicable in all cases are—that the house should be well lighted, both by natural and artificial light; the floor should be in good condition and perfectly drained so that it will be impossible for pools of water to collect; that in cold weather a supply of heat be provided that will keep the house at a comfortable temperature under all reasonable circumstances and so arranged that the machinery of a locomotive will be rapidly dried out and the workmen will be able to quickly warm themselves after having been out in the cold. The ventilation should be such as to keep the house comparatively clear of smoke and steam under all ordinary conditions. Work benches, small stores, tools that are often used, emery wheels, etc., should be provided at convenient points throughout the house to reduce the amount of travel back and forth to a minimum.

Comfort of the workmen—not so much their physical comfort except as that influences their mental condition—but a satisfied feeling throughout the force, is a most important factor in efficient engine house work. Lockers, wash and toilet rooms, kept in first-class condition, are necessary adjuncts to all modern engine houses and should not be overlooked in any case. Where the piece or bonus method of payment is in use the times and prices should be based on the facilities and conditions at each place. If the day rate is in force, good sound horse sense in dealing with individual cases is essential.

Even with the very best conditions, as outlined to some extent above, unless the organization of the force is on a sound basis, the results will be unsatisfactory, but if the engine house force is properly organized, excellent results can be obtained with very ordinary conditions. It is impossible to lay down any set rules for the organization of terminal forces which would fit all cases except to say that the path of responsibility be direct and clearly defined. Each foreman, and indeed each workman, should have his duties clearly set forth and be held entirely responsible for their satisfactory performance. It has been proven that ample supervision, instead of being a heavy charge for non-productive labor, will prove to be a decided saving because of increased efficiency.

Track Arrangement.

Cost of the ground, shape of the plot and capacity of the terminal have so large an effect upon the relative location of the different buildings and the location of the tracks in the neighborhood that but a few general principles can be given as universally applicable. In the first place the arrangement should be such that when the locomotive starts for the turntable it will receive coal, sand, water, be inspected and have the fire and ash pan cleaned without any switching and on a direct line. Arrangements should be made so that it will be possible to pass any locomotive around those that may be ahead of it and on to the turntable after completing any one or more of these various operations. There should be separate tracks for incoming and outgoing locomotives, with either cross-overs or special arrangements, so that, if necessary, outgoing engines can undergo the same operations as incoming locomotives. This is best arranged by having a small cinder pit on the outgoing track separate and distinct from the main cinder pit, although located adjacent to it; one or more water stand pipes on the outgoing track and a cross-over in the case of a trestle coal chute or a separate hopper in the case of a multiple track chute for coaling.

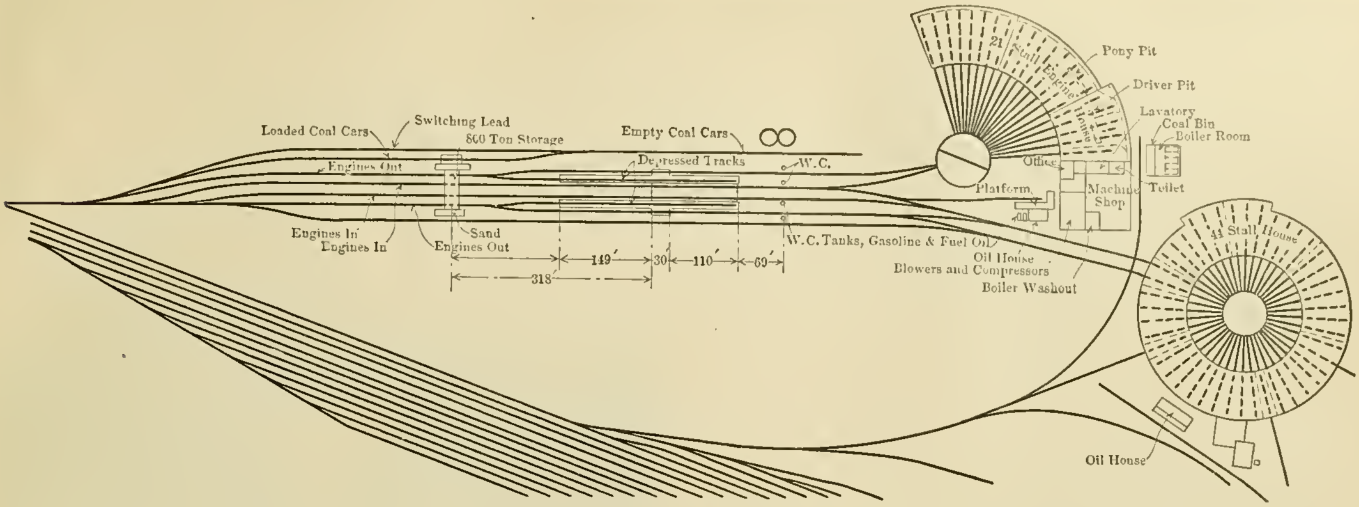
Standing tracks for storing locomotives which either do not have to go into the house at all or have been given the attention required in the house and are ready for service, but are not yet ordered, should be provided and arranged to permit any locomotive standing on them to reach the outgoing track without inconvenience. While most of the locomotive terminals that have been designed in the last six or eight years have an arrangement of tracks which, as conditions will permit, include most of the ideas mentioned, we only present three of the latest examples built, all of which are located on the Boston & Albany Railroad, and although erected simultaneously are different in many respects. In the first place, the type of coal chute used requires a different track arrangement, that at Beacon Park having a trestle type with pockets on the sides and the other two designs having hoppers supported by a steel structure and spanning several tracks. It will be noticed that in each case there are four tracks coming to the turntable from the cinder pit, with the exception of West Springfield, where future plans make it inadvisable. Two of these tracks are for incoming and two for outgoing locomotives. This gives ample provision when cross-overs are provided for separating any locomotive out of a bunch and getting it to the house ahead of others.

Other features of the layout are evident in the illustrations and while these arrangements may not be ideal they are well suited to the conditions at the various points mentioned. Beacon Park at present handles 107 locomotives per day, West Springfield 101 and Rensselaer 47.

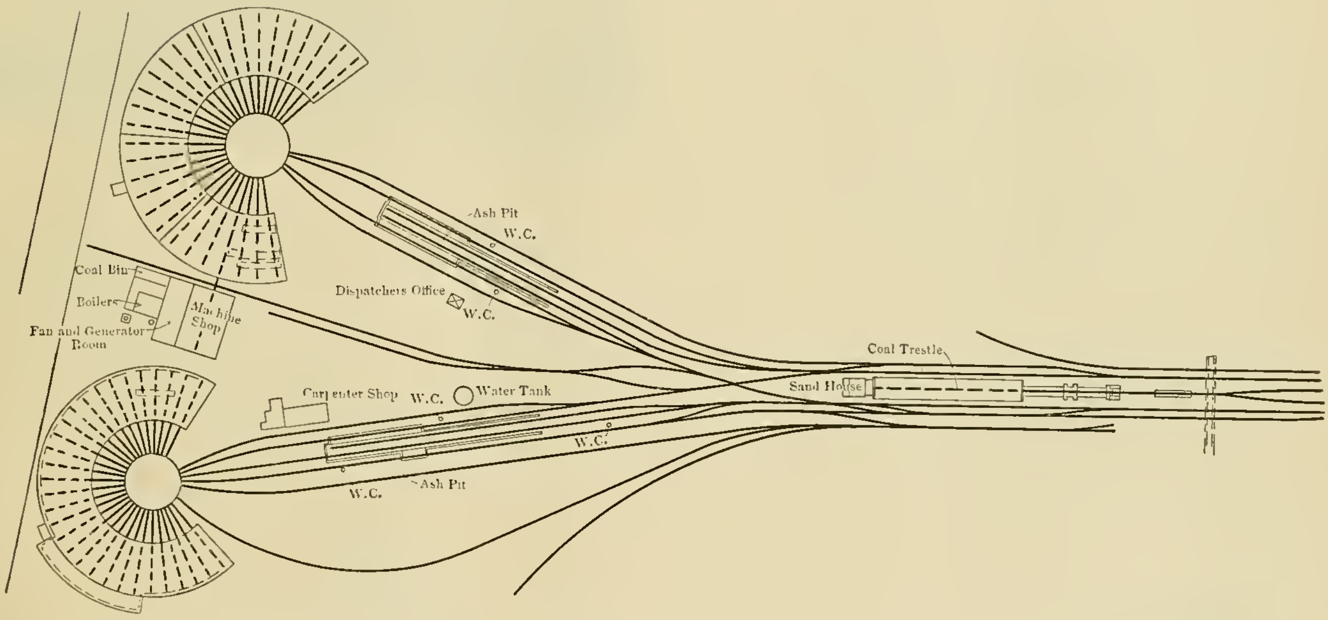
Turntables.

The very general and increasing introduction of the Mallet articulated compound locomotives makes the proper length of the turntable a matter of considerable importance. Where the articulated locomotives are to be used in road service it will, of course, be necessary to turn them the same as other locomotives and while 100 ft. has up to very recently been considered the maximum length for a turntable this will have to be increased when locomotives with over 90 ft. total wheel base, such as have recently been built, are to be handled. It is practically impossible to say that the articulated compound engines will not be used at any given point inside the next ten years and it is advisable to give this possibility full weight in deciding upon the size of the turntable.

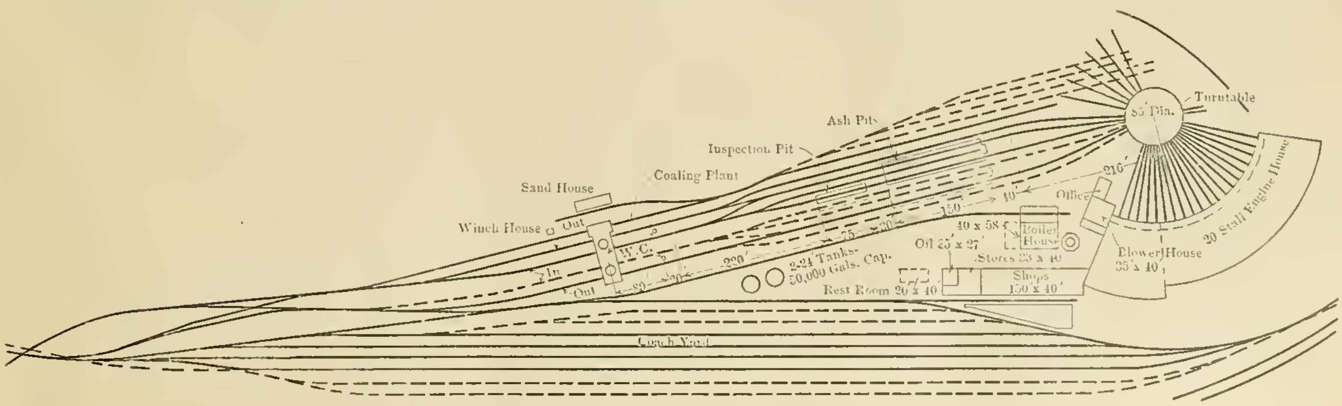
That turntables should be power driven in all cases is not disputed, and with the successful arrangements, employing gaso-



TRACK AND BUILDING PLAN OF THE WEST SPRINGFIELD LOCOMOTIVE TERMINAL OF THE BOSTON AND ALBANY RAILROAD.



TRACK AND BUILDING PLAN OF THE BEACON PARK LOCOMOTIVE TERMINAL OF THE BOSTON AND ALBANY RAILROAD.

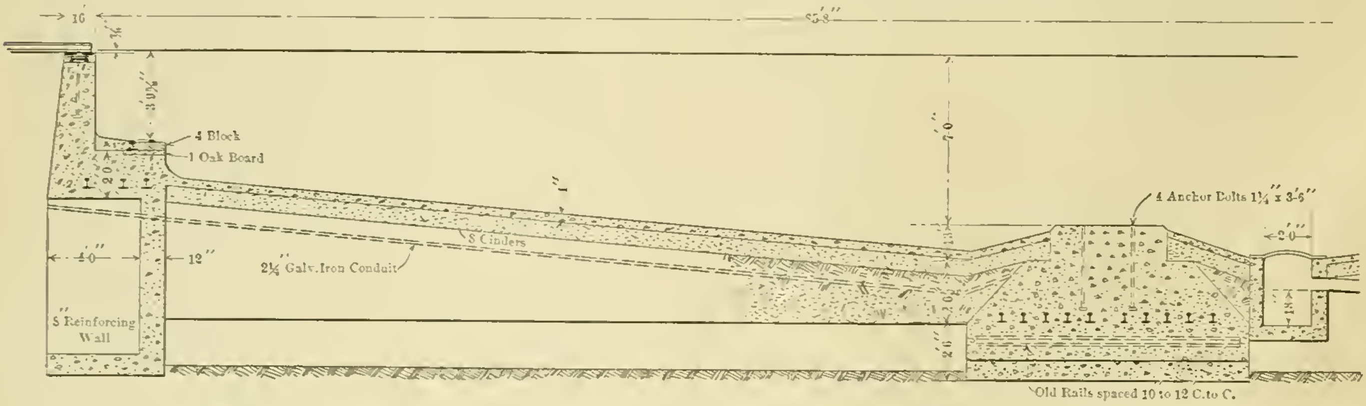


TRACK AND BUILDING PLAN OF THE RENSSELAER LOCOMOTIVE TERMINAL OF THE BOSTON AND ALBANY RAILROAD.

line engines or electric motors, now in use, which may be applied to either old or new tables, it is unnecessary to give this question any discussion. The advisability of having two separate sources of power for operating the table, as, for instance, a gasoline engine on one end and an electric motor on the other, the latter to be used normally, is worthy of consideration. As most roundhouses are now provided with electric current it is considered profitable to use the electric motor on the turntables at such places; but with the forces organized to work with a power driven table all care should be taken to prevent its failure and, because of the difficult conditions, more or less unskilled handling and the possibility of accidents, it is considered wise at some points to install an emergency source of power. The electric circuit leading to the turntable motor should always be underground and the contact at the center pin should be well protected. A duplicate circuit leading to this motor from the source of power is advisable if the wires are exposed at any point. These circuits should never be put on top of the buildings where they would be subject to injury from wind or fire.

Locks should always be installed on the turntable, and it is well to have them connected with a signal light located on the table. It is also important to have the tracks line up with the table at both ends.

One of the illustrations shows a turntable pit which is practically ideal in climates where there is much snow or cold weather. The floor is of concrete and drains to a large outlet. The walls are also of concrete of ample thickness to retain their position and prevent cracking and are reinforced along the top by two circles of inverted rails, which are set flush with the top of the wall and give a bearing and fastening for the ends of the track rails. This distributes the blow over the concrete and prevents crushing at the rails. A 10-inch wooden cap is sometimes successfully used for the same purpose. A particularly noticeable feature of the pit illustrated is the arrangement of that part of the floor outside of the circle rail from the side wall to the top of the rail, so that it is not possible for snow or ice or any débris to collect outside of the circle rail. Short wooden or steel ties make a satisfactory support for the circle rail. A recess formed in the outer wall and covered over at the top forms a very handy place to store large wrenches, jacks or other tools usually found lying on top of the table or in the bottom of the pit and makes it possible to examine or repair the trucks on the ends of the table. A horizontal extension of the foundation of the circle rail



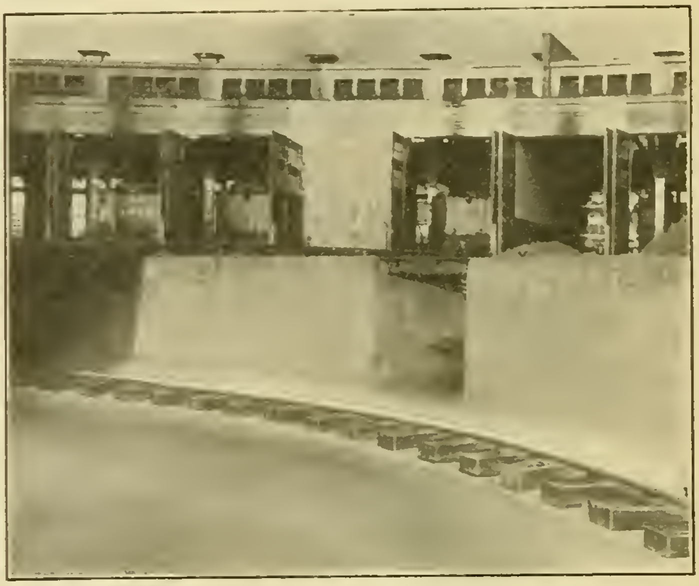
SECTION OF TURNTABLE PIT USED ON THE BOSTON & ALBANY RAILROAD.

on diametrically oppposite sides of the pit, for a short distance inward, will be found very useful when it is necessary to jack up the table. Tar concrete is sometimes used for a pit floor, as it has great elasticity and will not crack easily from heaving of the soil below.

At points where the snow fall is large a spiral arrangement of 2-in. pipe having six or seven turns, in the bottom of the pit and connected to the steam supply, will be found to be of great advantage. When this is installed, arrangement is made to close the drain leading from the pit and steam being turned into this pipe, the lower end is opened sufficiently to cause a good circulation; all of the snow in the pit is melted, forming a pool of warm water, into which the snow from the table and the circle inside of the house can be quickly shoveled and melted. When the pit is half full of warm water the drain can be opened and the water discharged.

Roundhouse Structure.

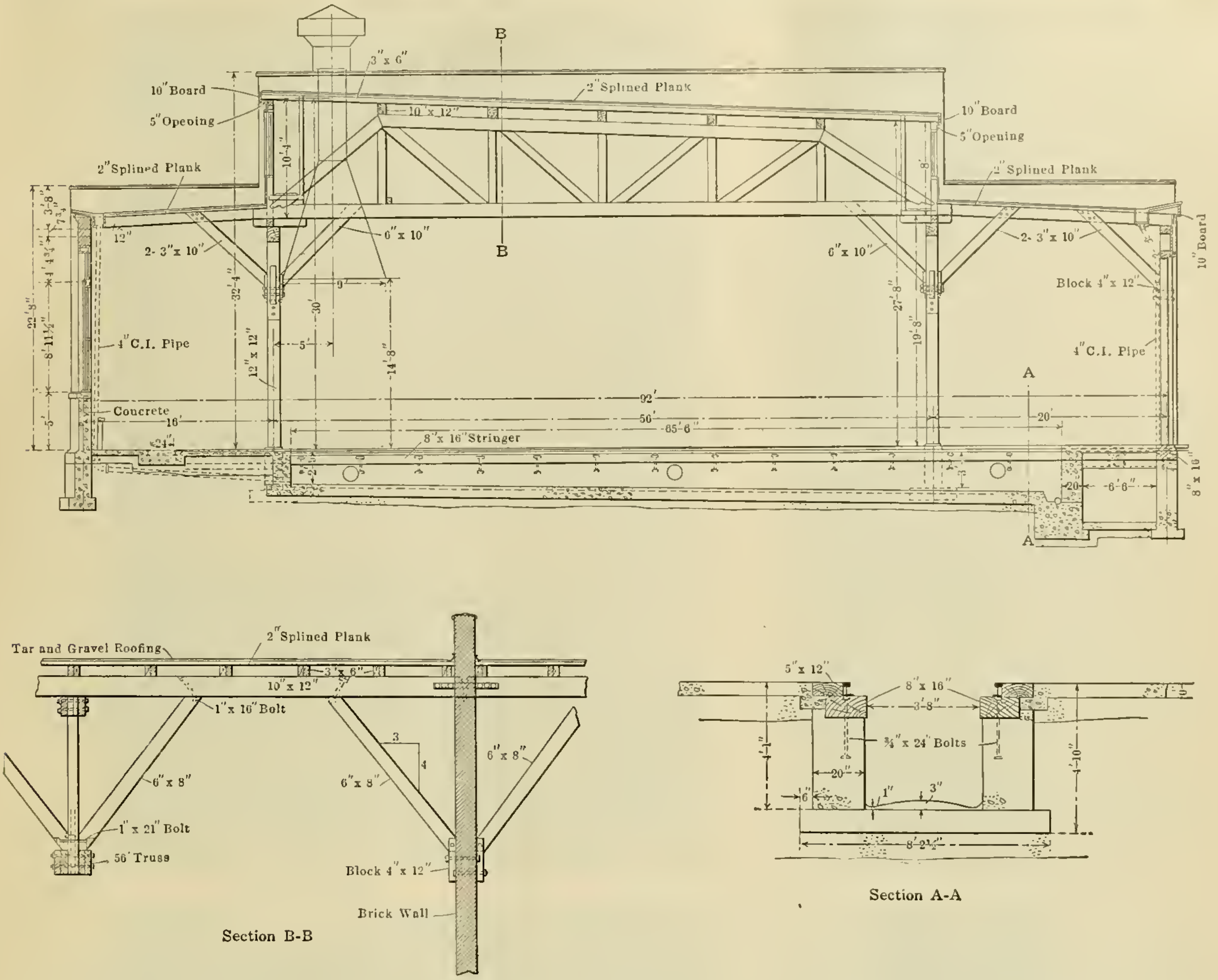
The number of stalls or pits required at any point is easily arrived at by determining the proportion of the total time that the locomotives, which are to be handled, are in the hands of the mechanical department. Under normal conditions on most



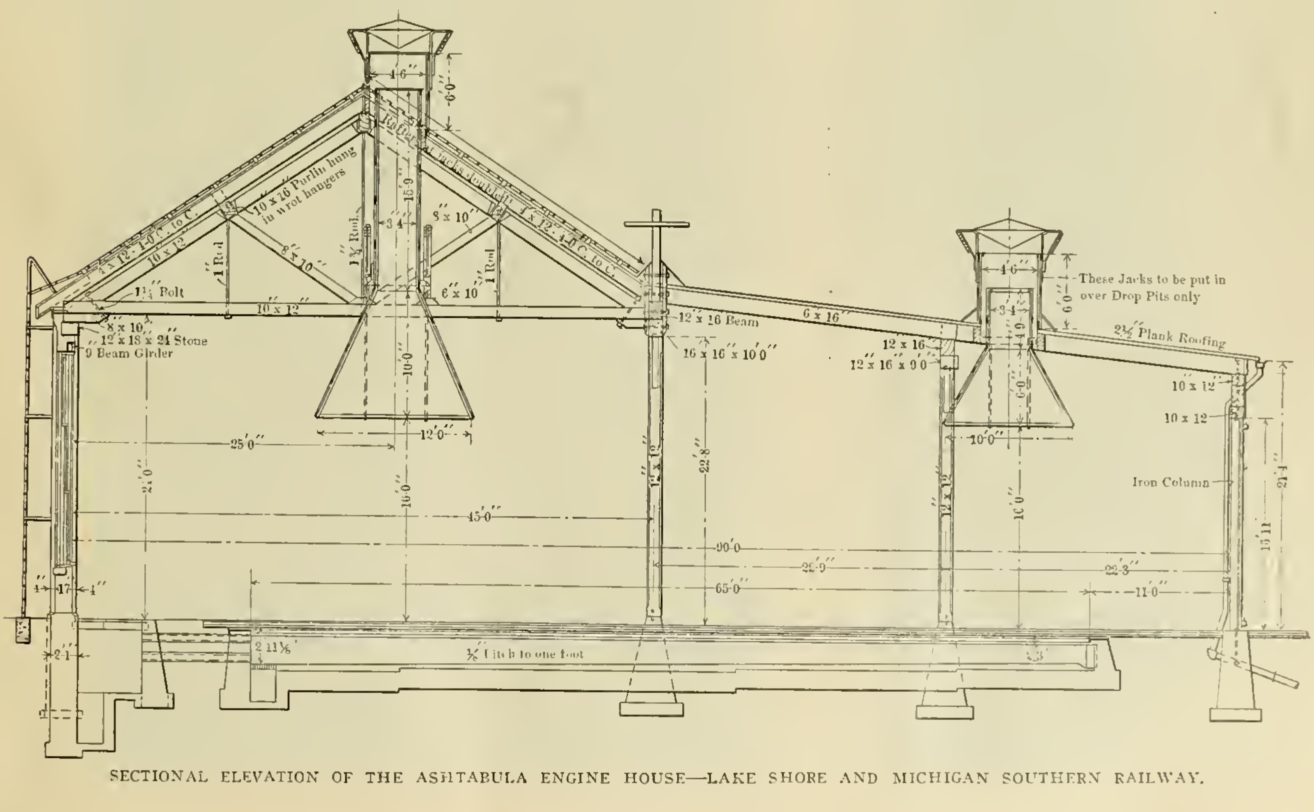
VIEW OF TURNTABLE PIT AT WEST SPRINGFIELD TERMINAL—B. & A. R. R.

roads this should not exceed 25 per cent., and the number of pits required, assuming that all locomotives are to be taken care of inside of the engine house, is equal to 25 per cent. of the total number assigned to the division. This allows an average of six hours per locomotive on each pit, if it is assumed that all of the engines on a division are turned during 24 hours. The average detention, however, should not be more than three hours, leaving ample leaway for a sudden rush of power into the house if arrangements are made for storing engines ready for service outside of the house, which can be done without any detriment to the power and with little expense. The amount of repair work done at each particular point also influences the number of pits, and it may be advisable to add on three or four extra pits, forming, in effect, a shop to be used entirely for repair work. An example of an arrangement of this kind is seen in the East Buffalo engine house of the New York Central Lines, which was fully illustrated and described in the January, 1909, issue of this journal.

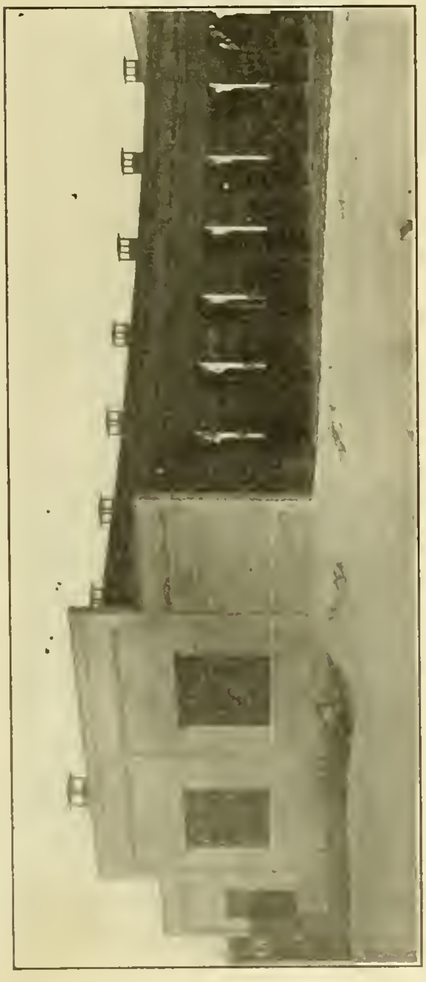
There are practically but two materials now being used for



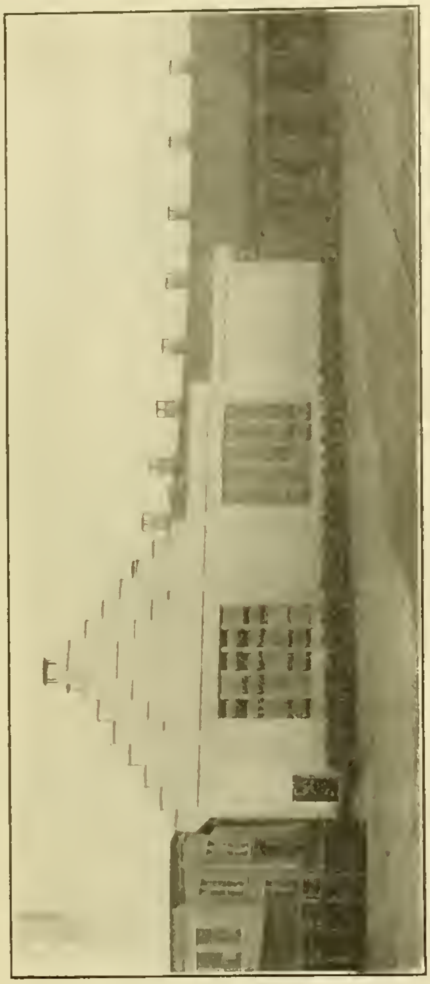
SECTIONAL ELEVATIONS OF THE 1908 STANDARD ENGINE HOUSE OF THE NEW YORK CENTRAL LINES AS ERECTED AT WEST SPRINGFIELD, MASS. THE 1909 STANDARD DIFFERS FROM THIS ONLY IN DETAILS.



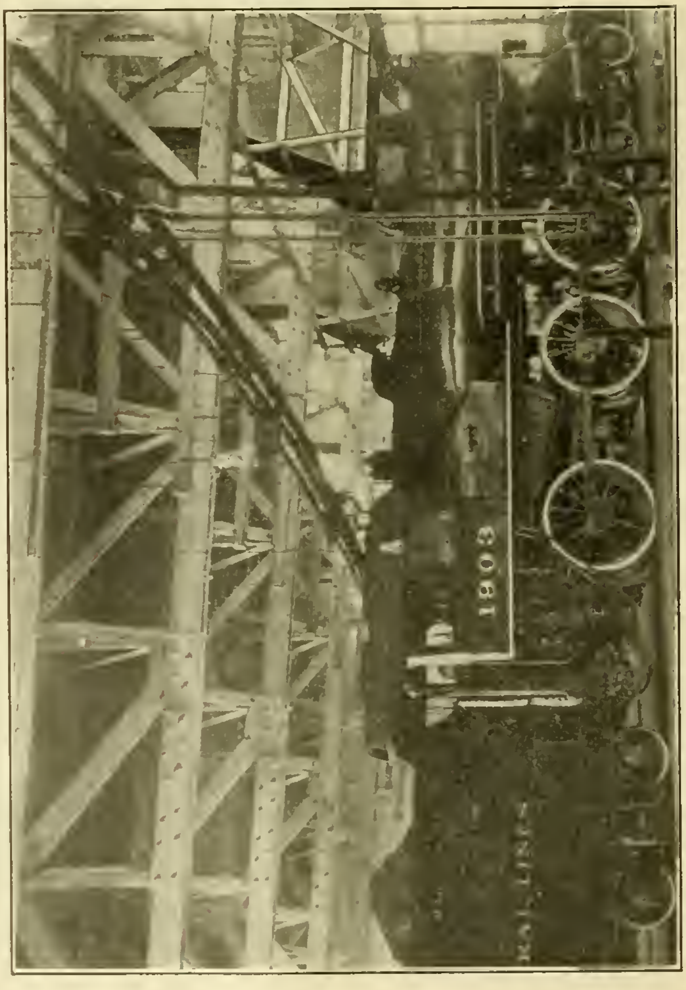
SECTIONAL ELEVATION OF THE ASHTABULA ENGINE HOUSE—LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.



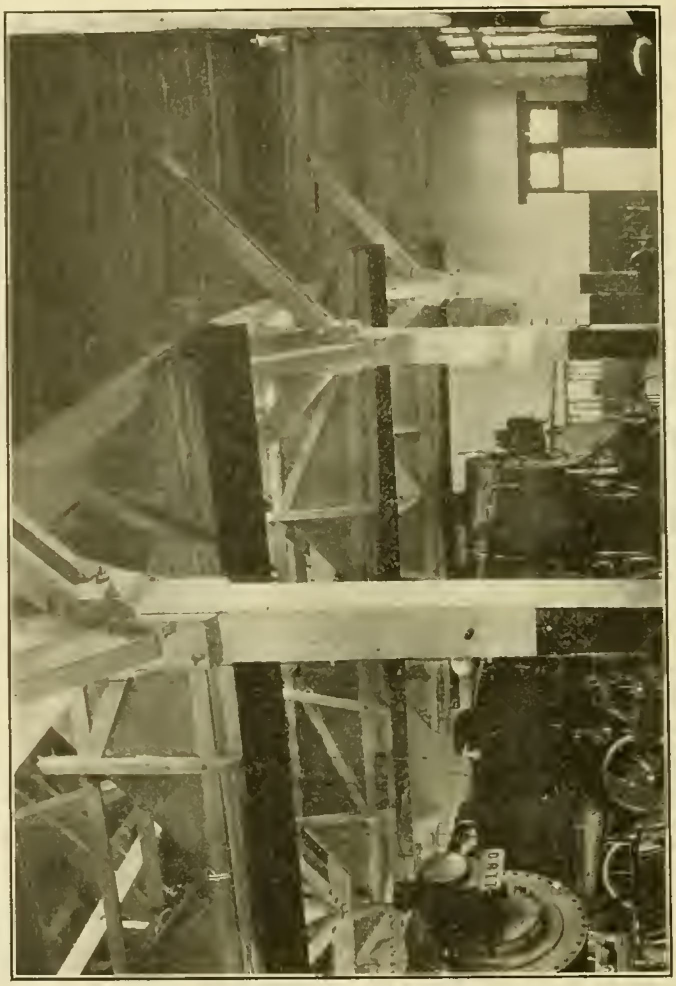
VIEW OF THE WEST SPRINGFIELD ENGINE HOUSE.



VIEW OF THE BEACON PARK ENGINE HOUSE.



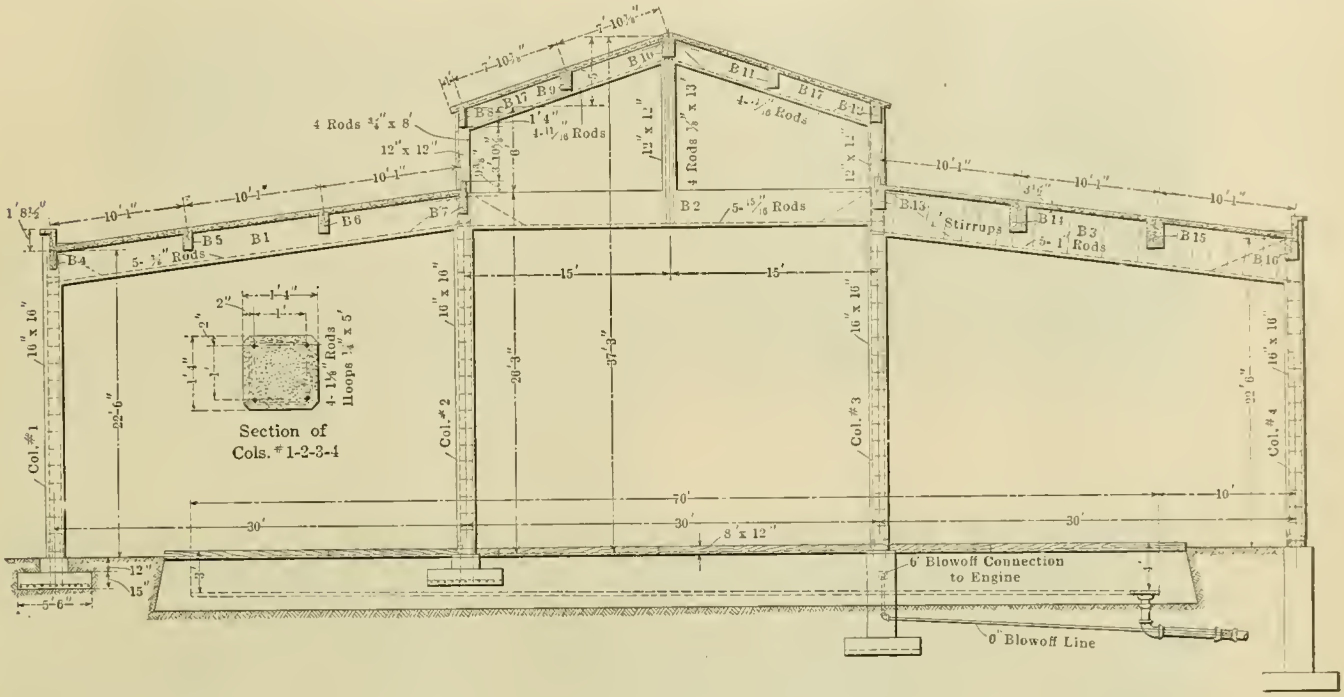
INTERIOR OF THE WEST SPRINGFIELD ENGINE HOUSE, SHOWING ROOF TRUSSES, SMOKE JACKS AND GOOD NATURAL LIGHTING.



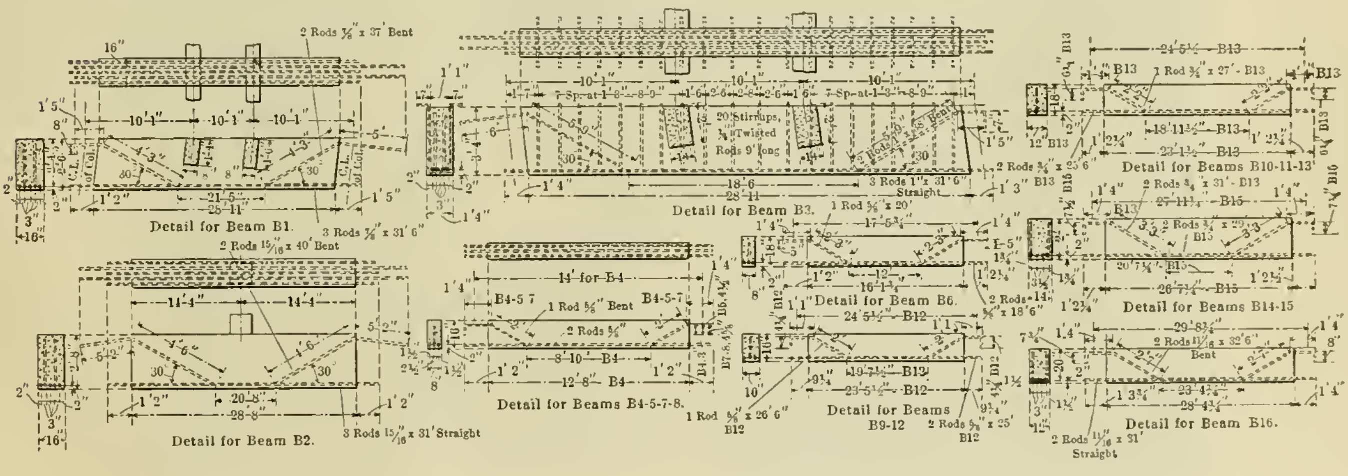
INTERIOR OF THE DROP PIT SECTION OF THE WEST SPRINGFIELD ENGINE HOUSE, SHOWING DOUBLE SMOKE JACKS.

the walls of engine houses, viz., brick and concrete. The roofs are usually of wooden construction, but in a number of cases reinforced concrete is being tried and a few houses have steel roof trusses. It is possible to have a combination of the three principal materials, which has a number of excellent features. For example, there might be concrete pilasters in the outer circle, wooden roof structure and a brick filling below and above the the expense of repairs is comparatively small, whereas if the outer wall is of concrete, the damage is likely to be considerable, as is also the case where it is all of brick.

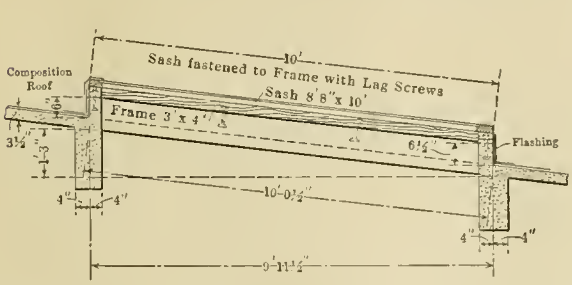
Reinforced concrete seems to have many features of advantage as a material for engine house structures, but no examples have been in service a sufficient length of time to determine its disadvantages accurately. Among recent examples of houses built



SECTIONAL ELEVATION OF THE REINFORCED CONCRETE ENGINE HOUSE OF THE UNION RAILROAD AT OAK HILL, PA.



BEAM DETAILS OF THE OAK HILL ENGINE HOUSE.



SECTION THROUGH SKYLIGHT OF THE OAK HILL ENGINE HOUSE.

windows in the outer circle, the lintels being made of I-beam set into the concrete posts. One advantage of an arrangement of this kind is the fact that when an engine goes through the wall of a house, as occasionally happens in spite of all precautions,

exclusively of this material is a small house on the Lehigh Valley at Tifft Farm near Buffalo and a house on the Union Railroad at Oak Hill near Pittsburgh. The latter structure is shown in the illustrations. It is also being tried out at a number of other points throughout the country. Wood, however, still forms the most popular material for roof construction in an engine house and has much in its favor. The three engine houses on the Boston & Albany, mentioned above, have a wooden roof structure arranged in two different designs, as has also the engine house at Ashtabula on the Lake Shore & Michigan Southern Railway. Steel roof trusses have been successfully used at a number of points, but require very close attention to prevent rapid deterioration.

For economy in heating it is advisable to have the volume of air in the house as small as possible, which means that the roof should be flat and set low. For good ventilation, however, which is fully as important as heating, it is advisable to have either considerable pitch to the roof with openings at the proper points, or a large monitor with windows at the sides.

For good lighting it is necessary to have either a roof which permits lighting in the center of the house or to have high walls giving large light area on the inner and outer circles. The lighting and ventilating consideration will overcome the heating feature at a majority of places and the type of house built at West Springfield and at Ashtabula, in both of which all of these features were given most careful study, illustrate two successful methods of obtaining good light and ventilation without an excessive increase of volume and consequent difficulty in heating. In the West Springfield design there is a 5-in. opening underneath the eaves of the monitor around the roof which permits a circulation of air into and out of this part of the house and rapidly carries away the steam and gases that naturally collect at this highest point. The purlins are laid parallel to the direction of the air currents, greatly assisting the free and rapid movement of the air. When the weather permits, opening of the windows still further assists in the discharge of the fumes. This type of structure gives an exceedingly well distributed light area, and, as may be seen in the interior view, there are practically no dark places anywhere in the house.

Since the interior of an engine house, especially at the top, is usually at a fairly warm temperature, it is not necessary to have a decided pitch to the roof for the purpose of preventing a heavy load of snow in cold climates, and it is necessary only to give sufficient pitch for drainage. In this connection it might be mentioned that it is very desirable not to have the roof drain into the inner circle and if the form decided upon slopes that way, the eaves should be pitched backward so as to make the gutter come just inside the doors and drain through pipes inside of the house. This will prevent the collection of ice along the inner circle, which is otherwise unavoidable in cold weather. A steam pipe running along the roof with connections extending down below the level of the roof into each gutter pipe has been found very useful for thawing out frozen drain pipes, but is of value only where the drain pipes are inside of the house.

GENERAL VIEW OF THE REINFORCED CONCRETE ENGINE HOUSE AT OAK HILL—UNION RAILROAD.

INTERIOR OF OAK HILL ENGINE HOUSE SHOWING ROOF BEAMS AND SMOKE JACKS.

Most of the good prepared roofings have proved to be satisfactory for covering roundhouses and are now very generally used.

The proper distance between the walls is subject to the same considerations that were mentioned in connection with the length of the turntable and, as a rule, this dimension should be about 10 ft. greater than the length of the table. Some of the recently designed engine houses have a distance inside of 92 ft., which is ample for the present designs of locomotives, with the exception of the articulated type, but when it is considered that locomotives are now built which are 108 ft. 8 in in length over engine and tender and 98 ft. 5⅛ in. total wheel base, it will be seen that the same difficulties encountered on the introduction of the Pacific type passenger locomotives are likely to again occur. It is probable that the articulated locomotive will be more or less generally used on all roads during the next ten years, and this fact should be given full weight in deciding upon this important dimension. The length of pits is, of course, determined by the same factors, and should be long enough to permit convenient

INTERIOR OF THE OAK HILL ENGINE HOUSE SHOWING SKYLIGHTS.
(FLAT SKYLIGHTS ARE NOT USUALLY TO BE RECOMMENDED.)

entrance into the pit from one end or the other when the locomotive is under the smoke jack.

The conclusions of the committee on buildings of the American Railway Engineering and Maintenance of Way Association on this subject are as follows:

> Reinforced Concrete Roofs for Roundhouses.—The conclusions as adopted were as follows:
>
> (1) Reinforced concrete should be used below the floor when it is cheaper than plain concrete.
>
> (2) The additional security against interruption to traffic from fire warrants the serious consideration of the construction of a roundhouse with a reinforced concrete roof.
>
> (3) When the roof is of reinforced concrete the columns should be of the same material.
>
> (4) Reinforced concrete should be used for the walls only where special conditions reduce its cost below that of brick or plain concrete and where plaster is not considered satisfactory.

Drop Pits.—Drop pits are, of course, a necessity in most engine houses, and there should be two sets on separate tracks, each to cover three pits, one being located and of a size suited for handling driving wheels and the other for truck wheels and tender trucks; the latter preferably being near the inner circle, so that the locomotive may be backed into place when it is necessary to drop the front truck. In the arrangement of drop pits it is advisable to so arrange the hydraulic jack and the movement of its carriage that it will not be necessary for men to be in the pit or below it when it is in operation. This has been done successfully in several cases by an air cylinder connected through sheaves to a cable or chain. A trolley hoist or jib crane covering the space between the tracks over a drop pit has been found of value for handling the removable sections of the floor, as well as driving boxes, eccentrics, etc. In some cases rails at gauge have been inserted in the floor of the house for a short distance on either side of the drop pit opening so that drivers taken out will not crush the floor.

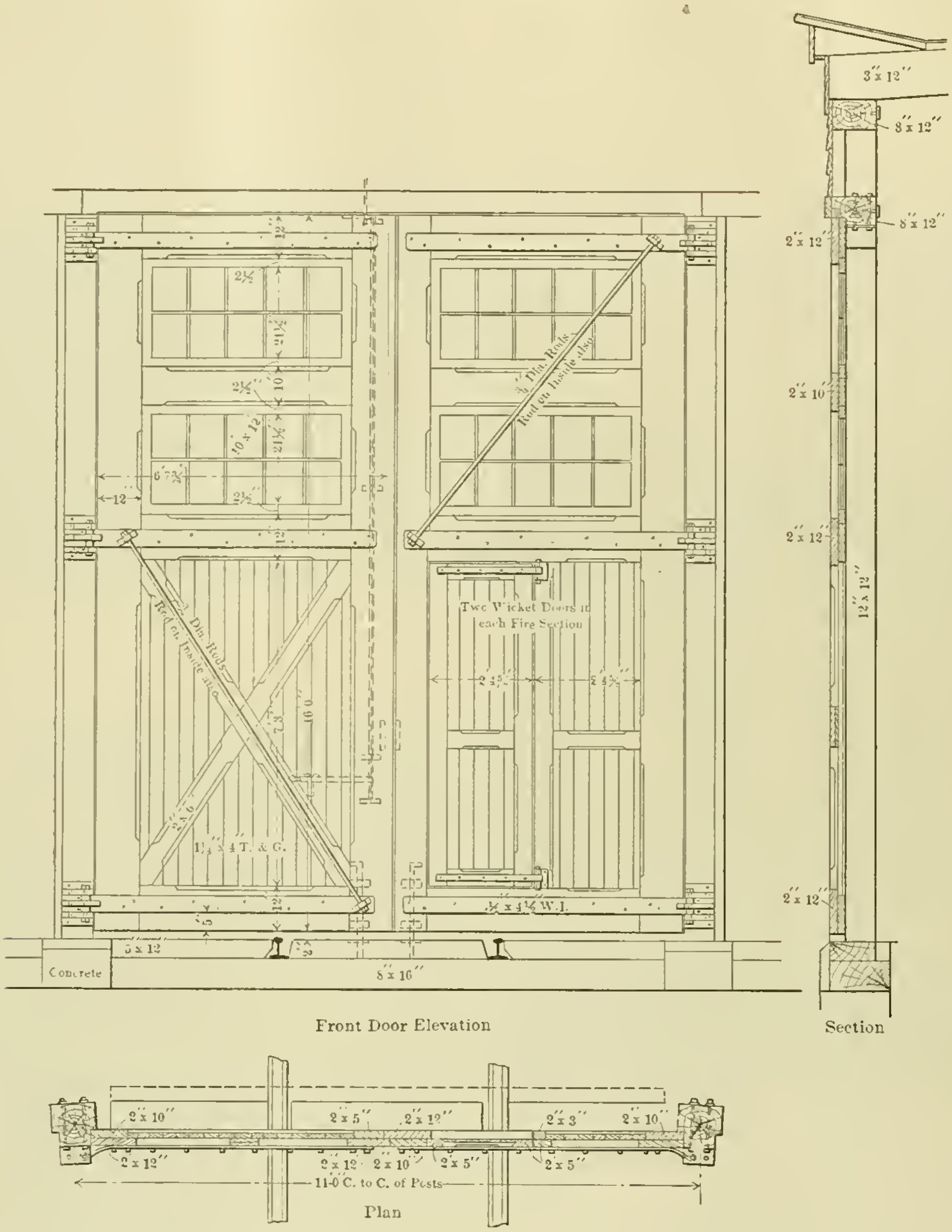
In the drop pit section of the house at West Springfield and a number of other points on the New York Central Lines, the outer wall is set back about 20 ft. and the drop pits are so located that it is not necessary for the tender to extend into the circle and the doors open while any wheels are being removed.

Fire Walls.—Fire walls of brick or concrete should be installed every seven or eight pits and be continued several feet above the roof. Openings fitted with automatic fire doors should be arranged at both the outer and inner circle. Fire walls are of advantage in cold climates for improving the average temperature and reducing drafts from open doors, as well as in case of fire. They also save fuel in a house not all of which is in use, as one or more sections can be closed off and not heated.

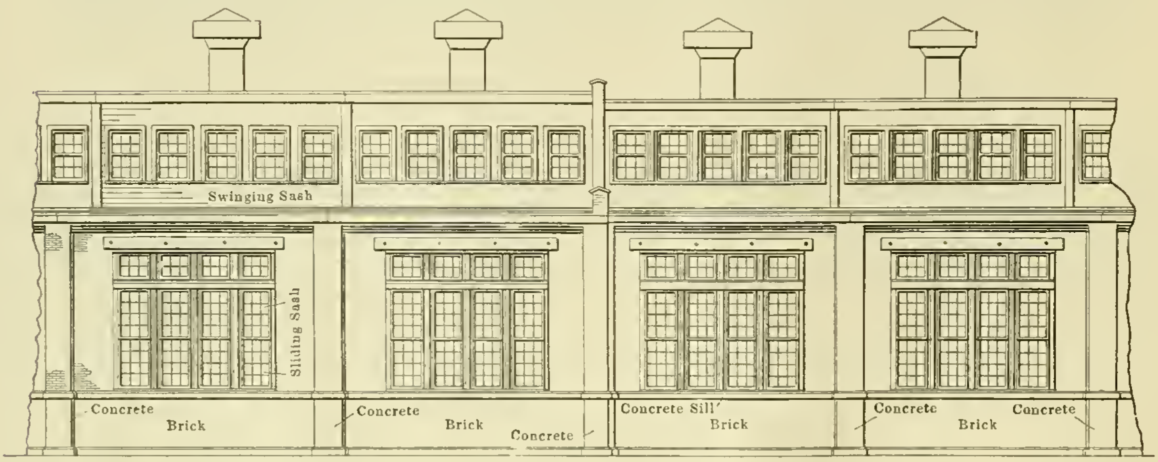
Floors.—After an engine house has been in service long enough to have all settlement of the foundations and of the filled in sections finished, a good concrete floor will probably prove to be the most satisfactory. Previous to that time, however, unless the ground below has not been disturbed, it is not advisable to install concrete, and paving bricks are very satisfactory for temporary use. In some cases creosoted wooden blocks set on a concrete foundation have been put in and proved to be most suitable. The floor should be as smooth as possible and well drained into the pits, so that it can be washed by using a hose at regular periods. The drainage feature is of importance also for keeping the floor dry, particularly along the sides of the pit where it is necessary for men to kneel down and where flexible electric cables will be lying around when men are working underneath the locomotive.

Good natural lighting has been mentioned above several times as being one of the most important features leading to a high efficiency in engine house work. In any, except very cold climates, the outer wall of a roundhouse should be very largely given up to lighting area, and in some of the most successful of the recently constructed houses, particularly the ones at Ashtabula and West Springfield, there is but little more than a pilaster for holding the roof trusses, between the window frames. The sill is brought to within about 5 ft. of the floor and the lintel is quite close to the eaves. On the inner circle the upper half of the doors should be given up to lighting and, if possible, a row of windows should be installed above the door frames. In this case the sash should be stationary, but for the windows in the outer circle there should be a movable sash for improving the ventilation during hot weather. Both the sliding and the swinging sash have proven satisfactory, the latter being preferably equipped with an operating gear, which can be reached from the floor. The sliding sash has an advantage for convenience in cleaning; but this feature can be well taken care of in the case of a swinging sash by a special brush, which will be described later. The latter arrangement has the advantage of giving a larger opening for ventilation and preventing direct drafts, but so far no operating device that is satisfactory in every way has been found. There are, of course, a number of arrangements that will operate the sash more or less perfectly, but the corrosive action of the gases soon coats the iron or steel parts with rust and soot and causes failure. The panes of glass should in all cases be small and the sash of very strong construction. Where windows are installed on the roof they should in all cases be vertical.

Doors.—Engine house doors have been the subject of considerable study during the past four or five years, and a number of designs have been elaborated, each answering the purpose to good effect under different conditions. These include the cus-



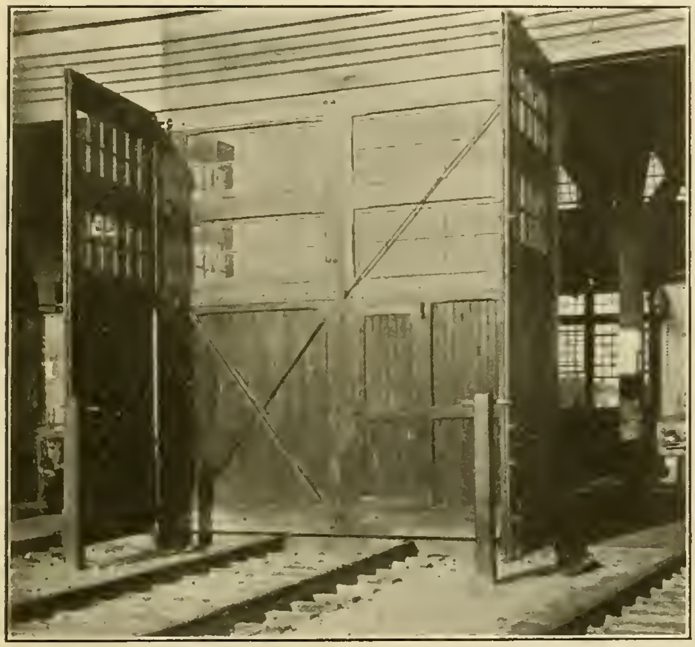
STANDARD 1908 ENGINE HOUSE DOOR OF THE NEW YORK CENTRAL LINES. THE 1909 STANDARD DOOR IS OF THE PITT BALANCED TYPE.



ELEVATION OF 1908 STANDARD ENGINE HOUSE OF THE NEW YORK CENTRAL LINES AS ERECTED AT WEST SPRINGFIELD.

tomary swinging door, the rolling lift steel or wooden shutter, the lifting door, which is lifted bodily, the Ritter folding lift door, and the Pitt balanced door.

In most cases the shape of the roof will influence the type of door to a considerable extent, especially where the lifting door is used, when the eaves on the inner circle must be at least 32 ft. above the rail level. If it is not possible to allow sufficient space between the top of the door and the eaves for good lighting area, it will be necessary to have the upper part of the door of glass, which eliminates the advisability of using the rolling lift door for this condition. The Ritter folding door has been found to



ENGINE HOUSE DOORS AT WEST SPRINGFIELD.

be very satisfactory for engine houses, as it can be used with a low roof, gives an opportunity for using windows in the upper section, and is quickly and easily opened.*

Taking everything into consideration, it is probable that for a majority of cases a swinging door of some type will be found the most suitable. They permit the installation of small doors without difficulty, can be made sufficiently strong to have a large area of glass, practically cannot become inoperative, and are the cheapest to install. The principal objection to the hinged door is found in the winter time in cold climates, where snow and ice may make it difficult to open and close, but if the roof is so designed that the eaves do not drain and form ice on the inner circle and the doors are properly designed and securely fastened, both closed and open, these disadvantages are overcome. One of the illustrations shows the 1908 standard New York Central hinged roundhouse door, which is of this type, and has proven as satisfactory as anything previously tried in places where heavy snow falls and cold weather are encountered.

During 1909, however, all of the new engine houses built on the New York Central & Hudson River Railroad have been equipped with a new type of door that seeems to have many special advantages for this use. It is called the Pitt balanced door, and has been in successful service in small sizes for a number of years. It is carried by a single roller carriage in the center of the top to which the connection of the door is pivoted. There is a roller guide at the top corner next to the post and two roller guides, one at the center and the other at the inner corner, at the bottom. In action, as the two doors are pushed outward at the center of the track, the edge of each door next to the post swings inward, being guided by the rollers top and bottom and at the same time the roller carriage moves toward the post until the door when full open is parallel with the track and half inside and half outside the house. The advantages of this arrangement are the same as those mentioned for a hinged door, and in addition it can be made considerably lighter than that type; it cannot be blown open; it opens and closes very easily, and when opened presents but half the usual area outside the house, requiring less than one-half the clearance and amount of snow cleaning in the circle.

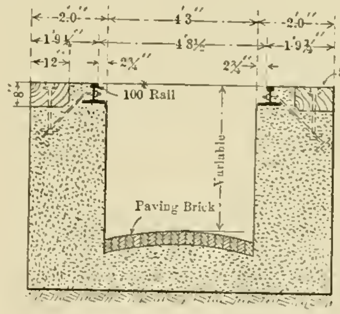
One of the greatest disadvantages found with hinged swinging doors in new engine houses is that the heaving of the track in winter interferes with their operation and the moisture from condensed steam in the interior swells them so that they bind at the top. There is also an opportunity for snow or dirt to get into the space between the door and its frame when it is open causing the hinges to be badly strained. These difficulties are provided against by leaving two or three inches clearance at the bottom, which can be closed by a slide working vertically and operated from inside and out, or by a long bag of sawdust, which can be thrown against it when it is closed in winter time. The top should be given good clearance when new to allow for swelling, the jamb being extended sufficiently to make a tight joint. The frame should be kept well away from the face and edge of the door, the joint being made by a weather strip. The floor should be extended beyond the outer face of the door for several inches and drop off abruptly.

Special attention should be given to the method of securing the doors in an open position, and probably the most satisfactory method is a heavy post, preferably set into a concrete foundation, which carries on its inner face a vertical angle iron forming a stop for two adjacent doors, each to be fastened open by a latch or bar secured to the post. This arrangement, when properly constructed, works very satisfactory.

For fastening the doors when closed, a locking device, which can be operated from both the inside and outside, should be used and so arranged as to catch before the doors are completely closed and draw them into position, pulling at the top.

The sash in an engine house door should be most substantial and the glass in small panes put in in a permanent manner to stand hard usage.

Pits.—In all of the later roundhouses the pits have been constructed of concrete, which, if of the proper mixture and properly put in, have proved to be very satisfactory. In some cases the bottom is lined with paving brick to prevent the breaking of the concrete by the fall of heavy parts. In all cases the pit should be so designed as to carry a jacking block at least 12 in. wide and set a sufficient distance from the rail so that the jack will rest upon it when under the bumper beam or tender underframe.



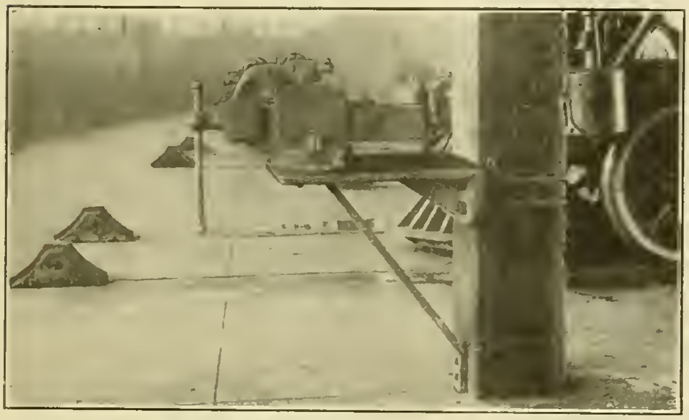
SECTION OF PROPERLY DESIGNED ENGINE PIT—UNION RAILROAD.

Where the jacking block is not supported by the pit wall it soon gets out of line and forms a low spot, in which water collects, making it very disagreeable for the workmen and unsatisfactory in every way. The illustration shows a cross section of a pit which is properly constructed in this respect, and is a satisfactory design. The drainage of course should be well taken off by a decided slope toward one end.

Stops.—Engine stops should be fitted to both rails of all tracks at a point where they will strike the front truck wheels when the stack is at the front end of the jack. Stops should be so designed as to offer the greatest resistance to the movement of the engine, but at the same time it is advisable to have them of such a height that they will clear the pilot. This, of course,

* See AMERICAN ENGINEER, January, 1909, p. 41.

means that they cannot be a sufficient height above the rail level to offer much resistance to the locomotive, and in a number of cases this difficulty has been overcome by depressing the track several inches just behind the stop, so that the pilot will pass over it and the front truck wheels drop into the depression against a stop 7 or 8 in. in height. In one of the illustrations stops will be seen which are excellent for their primary purpose, but which, in the case of an engine that could easily be stopped, will destroy the pilot before doing so. In some cases an emergency bumper is fitted close to the wall but this is not usually considered necessary.



EFFICIENT ENGINE STOPS, BUT TOO HIGH TO CLEAR PILOT.

Heating.—In modern engine houses there are practically but two systems for heating, one being direct radiation from steam pipes and the other by hot air forced through conduits, usually opening into the pits. Both of these systems have their advocates, and both are proving satisfactory under very similar conditions at different points. In both cases the exhaust steam from the power plant is the principal source of heat, but live steam is required to supplement it in very cold weather. The hot air system has many advantages, among which might be enumerated its much more rapid drying qualities, its low cost of maintenance, the improved ventilation resulting from its use, and the control over its distribution. The principal objections that have been raised to it are the difficulty in providing enough heat, which means that the amount of radiating surface required has been underestimated. A hot air system should be of a size capable of renewing the entire volume of air in the engine house every 10 or 12 minutes and should be capable of maintaining a temperature of 60 degs. in the house on the coldest day. These requirements cannot be fulfilled without ample area in the main air duct and the branches. These must be very thoroughly drained or the efficiency will be very decidedly reduced.

Direct radiation from steam pipes is preferred by many master mechanics principally because it gives a higher temperature locally, which permits men to warm themselves, thaw out oil cans, etc., with greater facility. Beyond this it has no advantages that are not common to the hot air system, and it has the disadvantages of being more costly to maintain, of not directly improving the ventilation, and of being less rapid in drying out the machinery of a locomotive. When installed in the pits, heater pipes cause an increase in the fog in the house because of water dripping upon them and on account of the leaks which may occur at the joints. In such cases the pipes should be well protected by a ledge which will protect them from injury when heavy pieces are allowed to drop and also, to some extent, keep the water draining into the pits from striking them. In installing steam pipes around the outer circle they should never be continued across the wall opposite to the end of the pit where, in case of the locomotive getting away, they would be liable to tear down a very large part of that wall and possibly cause the fall of a section of the roof.

The conduits carrying the steam pipes, if such are used, both for the house supply and for heating, should have gratings, so that the radiation from the pipes will aid in keeping a comfortable temperature. In most cases where hot air heat is installed there are openings from the hot air duct several feet above the floor under the windows of the outer wall and between the pits on the inner wall, the former, however, not being directly in front of the pit. The openings into the pit should be as numerous as possible, and all openings from a hot air system should be fitted with dampers.

In considering this subject the Maintenance of Way Association adopted the following conclusions:

> Heating.—Conclusions: (1) Heat should be concentrated at pits. (2) General temperature of the engine house should be kept between 50 and 60 degs. (3) The best method for heating engine houses is by hot air driven by fans through permanent ducts (under the floor where practicable). The supply should be taken from the exterior of the building (no re-circulation should be allowed). The air should be delivered to the pits under the engine portion of the locomotive. Air to be heated as far as may be by exhaust steam, supplemented as required by live steam.

Lighting.—Electricity should be used for artificial lighting whenever possible and satisfactory conditions will be obtained by the installation of enclosed arc lights located between each two pits about one-third the width of the house from the outer circle and about 9 ft. from the floor. In addition there should be a 16 c.p. incandescent lamp between each two pits about one-third the width of the house from the inner circle and located about 10 ft. from the floor. Each arc light should have a separate cut-out. Over benches, around lockers, over entrances, doors, etc., lights should be located as conditions require. There should be at least two sockets for portable lights between each pit. The turntable circle should be lighted with at least two arc lights, neither one of which should be placed over the turntable. The yard lighting should, of course, be as extensive as possible, enclosed arc lights on moderately high poles being satisfactory if near enough together. Incandescent lamps hanging in the house should be protected by a heavy wire guard.

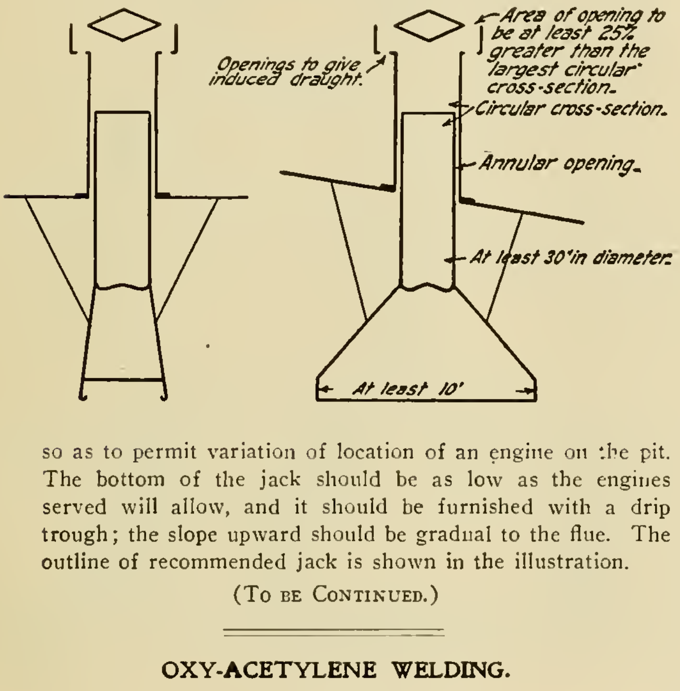
Smoke Jacks.—Many different materials have been tried and are being experimented with for smoke jacks. The conditions which the smoke jack has to encounter are of course exceedingly difficult, and so far no material has been found which is entirely satisfactory. Asbestos, both in plastic and board form, is being experimented with, and in a number of cases is reported to be satisfactory. At other points it is reported to be a failure. Wrought iron plates have been tried and if watched and carefully protected are a success. In the majority of cases, however, the wooden jack is being used, and with the smaller engines seems to answer the purpose fairly well, but is soon burned out by the larger locomotives. The jack should be designed to have a longitudinal opening at the bottom of about 14 ft., which will permit the engine being moved for valve setting without getting the stack from underneath the jack. The ends should have an angle sufficiently sharp to prevent any back draft when the stack is at the edge of the jack. The sides of the jack should extend 6 or 8 in. below the top of the stack, the ends, of course, being of a height to clear the highest stack, but can be fitted with flaps swinging in both directions, if desired. One of the illustrations shows a very satisfactory design of smoke jack, which is used at West Springfield, and another shows the double type of jack used in the same roundhouse in the drop pit section. It is desirable over pits having drop pits to have the jack sufficiently long to insure the stack being under it, no matter which driving wheel may be over the drop pit.

An annular opening of 4 or 5 in. should be left around the jack where it passes through the roof, for improving the ventilation. The jack itself should extend but a short distance above the roof line and the outer portion resting upon the roof will cover the opening, making an arrangement that will induce a draft from the house and pull the gases and smoke collecting under the roof up through this annular passage. The hood should be well designed to prevent any back drafts.

On this subject the conclusions given in the report of the Maintenance of Way Association at the 1909 convention are:

Ventilation.—This can best be accomplished by designing the roof so that "slope-up" is given to a continuous opening around the house and by the use of annular openings around the jacks. To obtain the full value of these continuous openings the purlins and rafters must be arranged so that they will guide the air currents up to the openings instead of obstructing them. The replacement of fresh air is most surely accomplished by hot air heating. Where no heating is needed, we believe that openings can be provided of such size that no mechanical ventilation will be required.

Smoke Removal.—Conclusions: Smoke removal should be separately provided for by the use of jacks, and the currents produced in the jacks should be utilized for aiding ventilation in the house by drawing air from the top of the house through annular openings leading into the top of the jack. Jacks should be without dampers, fixed and preferably built of non-corrosive material with cross-section not less than 30 in. in diameter. They should be of smooth material, circular in section above the hood, and extending well above the roof line; care in design should be taken to avoid any corners. The hood of a jack should have a minimum length of 10 ft.



so as to permit variation of location of an engine on the pit. The bottom of the jack should be as low as the engines served will allow, and it should be furnished with a drip trough; the slope upward should be gradual to the flue. The outline of recommended jack is shown in the illustration.

(To be Continued.)

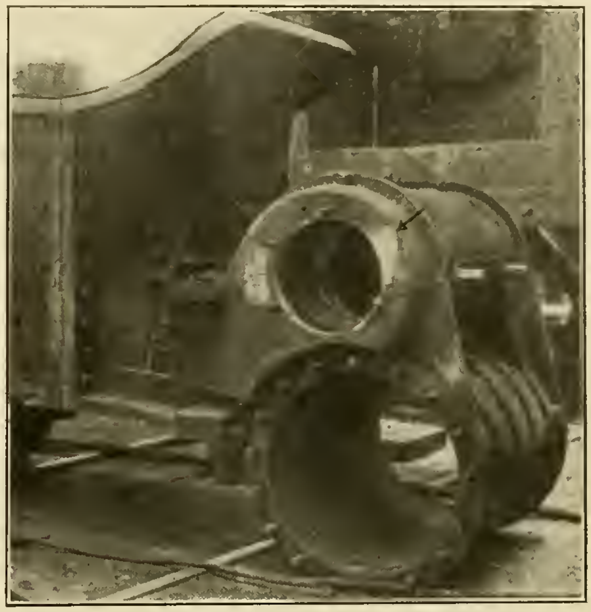
OXY-ACETYLENE WELDING.

Cecil Lightfoot.

Among the many interesting applications of the oxy-acetylene welding process is the repair of shrinkage cracks, sand and blow-holes in castings, both of steel and iron. Successful repairs to large castings are now being undertaken that a few months ago would have been considered impossible.

An interesting repair was recently made on a locomotive casting. The photograph gives some idea of the size and nature of the work undertaken. This cylinder was found to have a small blow hole on the piston valve chest. The hole on being chipped out, so as to get down to sound metal, developed to a size of 4" x 2" x 2". In order to eliminate the chances of cracking likely to be caused by unequal expansion, due to the intense local heat of the blowpipe, it was first of all necessary to pre-heat the casting. This was done by an oil burner for a considerable area around the place to be welded, and was gradually brought to a red heat. The time taken in pre-heating was about three hours. The oxy-acetylene blowpipe was then brought into operation and the metal adjacent to the hole was brought to a molten state, when new metal was pressed in until the hole was completely filled up.

The actual time in welding was one and one-quarter hours. During this time the oil burner was left playing on the casting. After the weld was completed, the casting was kept hot by means of the oil burner for about an hour. The burner was then removed and the casting covered over with sheet asbestos so as to keep any draft off and allow the metal to cool off slowly.



REPAIR TO LOCOMOTIVE CYLINDER BY OXY-ACETYLENE WELDING PROCESS.

The cost of making these repairs, including pre-heating and labor, was approximately $7.

APPRENTICESHIP ON THE SANTA FE.

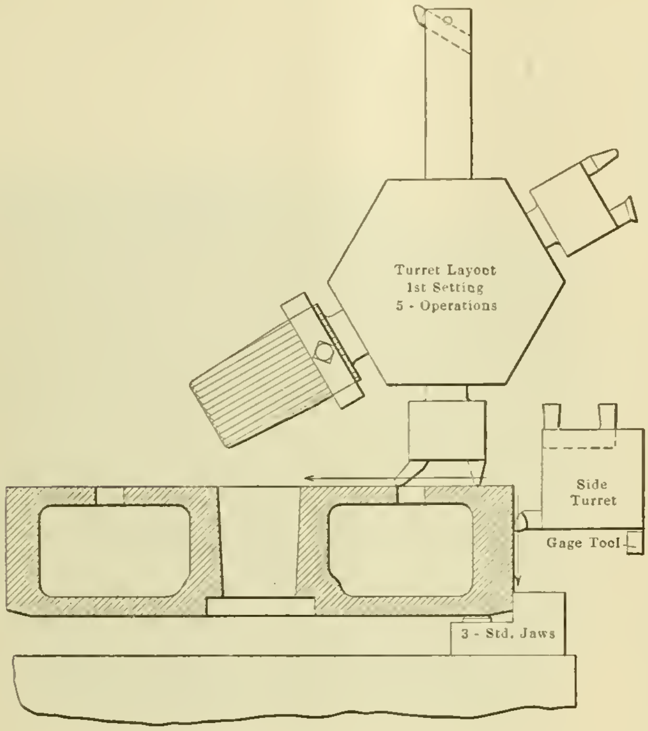
F. W. Thomas, supervisor of apprentices, has worked up a scheme whereby the apprentices at the smaller points will receive a modified form of instruction. Often there are only two or three boys at some of the smaller points, not enough to justify a regular instructor; these boys will be provided with the same appliances as are furnished the apprentices at the larger places, and they will be visited periodically by the nearest apprentice instructor and taught the same course that is now being taught in the regular apprentice schools. On December 1 all the apprentices on the system were receiving the benefits of the Santa Fe's liberal offer to assist them in mastering their chosen trades.

There are now established on the Santa Fe System schools as follows:

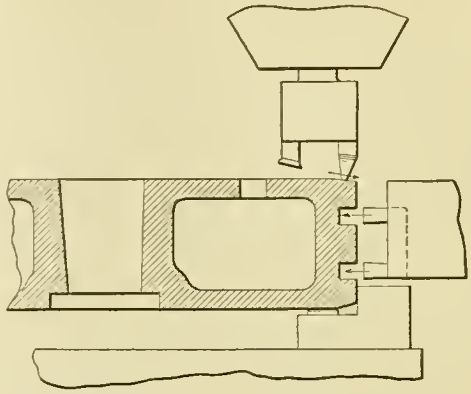
	Apprentices.		Apprentices.
Topeka	171	Clovis	15
Shopton	23	Albuquerque	38
Newton	19	San Bernardino	48
Arkansas City	7	Richmond	18
La Junta	23	Cleburne	56
Pueblo	4		
Raton	17	Total	439

—*From the Santa Fe Employees Magazine.*

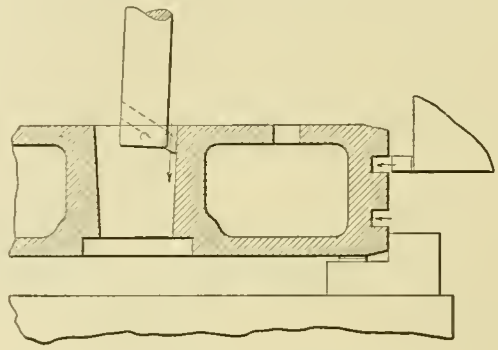
Pensions on the Rock Island Lines.—It is announced that pensions will be paid on the Rock Island Lines beginning with January. Edward S. Moore, second assistant to the president, has forwarded blanks to all heads of departments asking for facts concerning officers and employees whose entire time has been given to this company's service and who have attained the age of 70 years or will attain it by June 30, 1910; also those who have been in continuous service 25 years or more and have become permanently incapacitated, regardless of age.



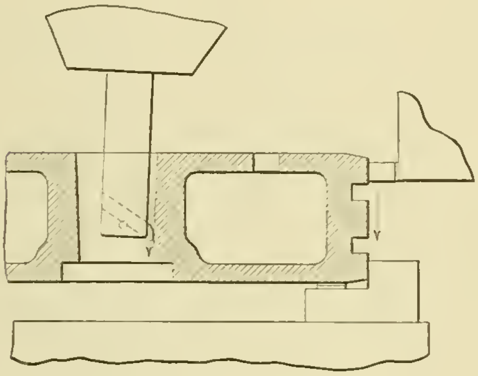
First Setting, First Operation.



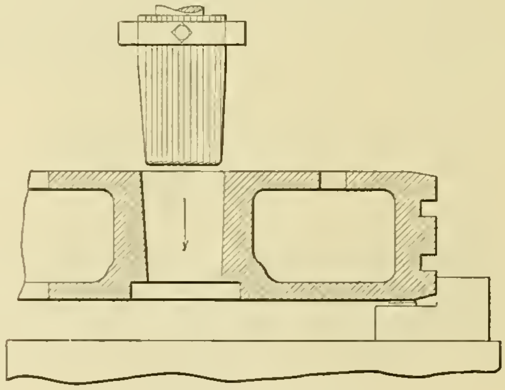
First Setting, Second Operation.



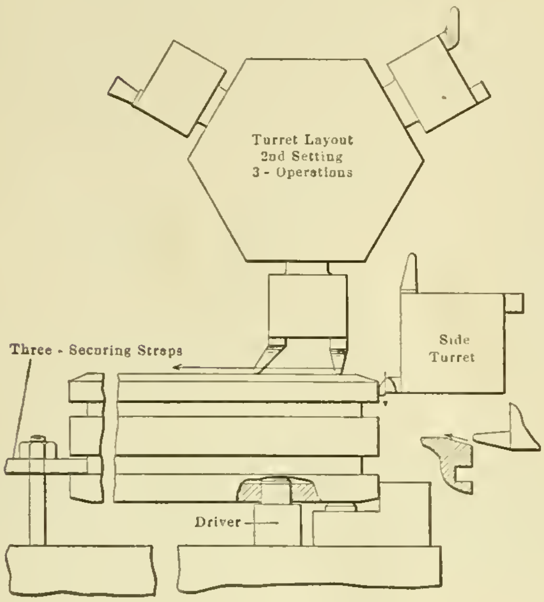
First Setting, Third Operation.



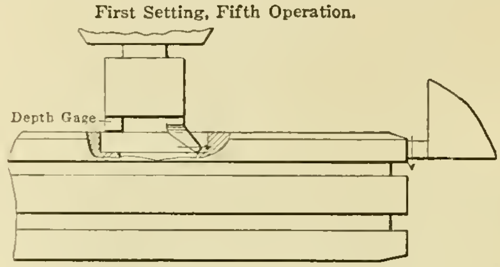
First Setting, Fourth Operation.



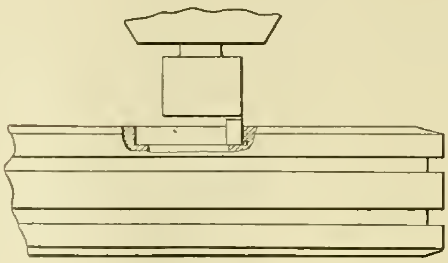
First Setting, Fifth Operation.



Second Setting, First Operation.



Second Setting, Second Operation.



Second Setting, Third Operation.

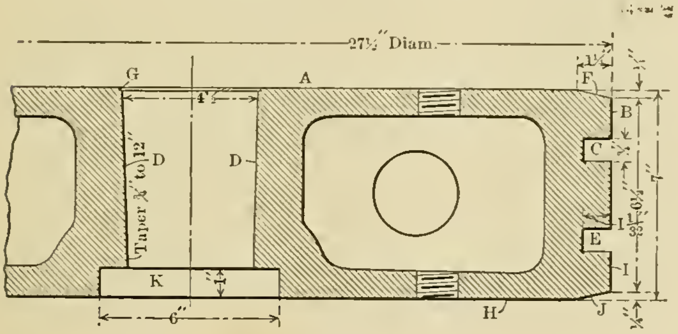
OPERATIONS REQUIRED FOR MACHINING A LOCOMOTIVE PISTON ON A VERTICAL TURRET LATHE.

OPERATIONS AND TIME REQUIRED FOR MACHINING A 27½-INCH PISTON ON A 36-INCH VERTICAL TURRET LATHE

Setting	Item	Surface Machined	Operations	Depth of Cut	Feed per Rev.	Revs. per Min.	Minutes Each Operation	Minutes Required Actual
Setting No. 1	1		Chuck work				5	5
	2	A & B	Set tools for cuts A & B				3	3
		A	Two tools } 5¾" length of cut } Simultaneous cuts	3-16	1-12	6	13 }	13
		B	One tool }	5-16	1-12	6	13 }	
	3	C & E	Set tools				1	1
		C & E	Two tools } Simultaneous cuts		1-48	6	9 }	
	4	F	One tool, }	3-16	1-12	6	4 }	9
		F	Finish				3 }	
	5	D	Set tool				3	3
	6	C	Set tool and finish } These operations were done while boring D	1-64	¼	6	3	3
	7	E	" " " "	1-64	¼	6	3	3
	8	B	Set tool and finish	1 64	½	6	2½	2½
	9	D	Speed up and rough remainder of first rough cut, 3"	1-16	1-16	36	3	3
			Second rough cut	1-16	1-16		4	4
	10		Swivel head to zero				2	2
	11	D	Ream				2½	2½
	12	G					2	2
	13		Remove Piston				2	2
Setting No. 2	14		Chuck				5	5
	15	H	Set tools				2	2
		H	Two tools } Simultaneous cuts	3-16	1-16	6	15 }	
		I	One tool, cut 1¾" long } Operations while cutting H.	5-16	1-16	6	6 }	15
		J	Rough and finish cut 1¼" long }	3-16	⅛	6	4 }	
		I	Finish	1-64	½	6	2	2
		K	Rough face	¼	1-24		2	2
		K	Bore	¼	1-48		2	2
		K	Finish		Hand		1	1
			Remove				3	3
					Total time,		120	90

MACHINING A LOCOMOTIVE PISTON.

In his study of the number and kind of machine tools required in a locomotive machine shop in the April, 1909, issue of this journal, L. R. Pomeroy specified a 37-inch rapid production vertical turret lathe for boring and turning pistons. One of our readers has questioned the average time of two hours for doing this work, as specified by Mr. Pomeroy. Investigation has proved that the time given was not only not too low, but that it may be accomplished in an average time less than this.



PARTIAL SECTION OF PISTON.

The accompanying table and illustrations show exactly how this work is being done in one large shop. This is not a *record* run, but represents results which may be gained by giving close attention to details and carefully planning the work. By using the vertical turret head and the side head at the same time it is possible to make a considerable saving in the time required for doing the job, as is indicated by a comparison of the totals of the last two columns of the table. This work was done on a 36-inch Bullard vertical turret lathe.

THE UNIVERSITIES AND INDUSTRIAL EDUCATION.

Charles Van Hise, president of the University of Wisconsin, briefly explained the extension work which is being done by that university in an address on "University Aid in Industrial Education" before the recent convention of the National Society for the Promotion of Industrial Education at Milwaukee, Wis.

"The rapid advance of applied knowledge in the world, and the absence of trade schools in the United States, have made it advisable for universities to give aid in industrial education. This has been done at the University of Wisconsin and to a lesser extent at other universities, by the establishment of the extension divisions. The extension division of Wisconsin, besides giving information by lectures and by institutes, as, for instance, bakers' institutes, gives systematic instruction by correspondence in many industrial lines. In this matter the correspondence schools, established upon a commercial basis, have led the way and performed a great service. The chief defects of such schools have been that each man must work by himself and that he does not come in contact with his teacher. The inevitable consequence is that comparatively few men have the stamina to continue long in study. The great majority drop out of the courses which they begin. Realizing these defects the University of Wisconsin has handled its correspondence work for artisans so that groups of men work together and meet a teacher, the traveling professor. This could only be successful by the cordial co-operation of the manufacturers. The manufacturers, and especially those in Milwaukee, have furnished class rooms in which the men may meet; not only this, but they pay their men for the time they are receiving instruction, an hour once a fortnight.

"This attitude upon the part of the manufacturer is broad gauged liberality, based upon a desire to help his men to improve themselves as well as to have the services of trained men.

"The traveling professor and the class room work place study by correspondence upon a new and higher plane. Under the new conditions the great majority of students persist to the end of their courses. The work of the Wisconsin extension division has met with enthusiastic support in this State and pending the wide development of the trade school it is the best method yet devised to give industrial education.

"Even when the trade school is fully developed, as it will be in the future, the extension work for artisans will be continued. Men need a broader training than a simply vocational one. They need to go farther than the trade school. When the trade schools are able in this State to do satisfactorily the vocational work demanded, it will be the aim of the University of Wisconsin to continue to teach the artisan after he leaves the trade school, not only in advanced studies relating to his vocation, but in studies which concern his duties as a citizen, and which concern him as a man. It is our desire to open to all the way to a higher intellectual and spiritual life."

FUEL ECONOMY ON TESTING PLANTS AND RAILROADS.*

H. H. VAUGHAN.

Most of us have at one time or other been confronted with the statement that there was a terrific waste in the operation of a steam engine, something like 5 per cent. of the heat developed by the coal burned under the boiler being all that was transformed into useful work. That such a statement is true is easily shown by comparing the coal consumption of an ordinary engine, taking say four pounds of coal per horse-power hour, and the work that is the equivalent of the heat in the coal. A horse power is 33,000 foot pounds of work per minute, so that a horse power hour is 1,980,000, or very nearly two million foot pounds of work. Four pounds of coal will develop about 60,000 b.t.u. of heat and as the mechanical equivalent of heat is 778 foot pounds per b.t.u., the total work that is the equivalent of the heat contained in the four pounds of coal is about forty-six million foot pounds. As only two million or under one-twentieth of this is developed as useful work, the statement that 95 per cent. is wasted is entirely true and cannot well be denied.

As is well known, the larger part of this 95 per cent. is not waste at all in the proper sense of the word, but is the necessary result of the natural laws governing the action of heat engines. We are very much in the position of trying to utilize sea water, pumped into a tower at Winnipeg, for power purposes. If the tower was 200 feet high and the discharge was into the river at a height of 750 feet above sea level, the best possible efficiency that could be obtained would be by using 200 feet out of the total head of 950 feet available, or about 21 per cent. The 79 per cent. that was lost on account of the impossibility of utilizing the total down to sea level would not be waste, but power rendered unavailable on account of the conditions under which it was supplied.

While not by any means an exact simile, such a case does to a certain extent resemble the conditions under which heat can be used in the heat engine. The heat that can possibly be utilized depends on the proportion of the range of temperature through which the engine works to the initial temperature, and the initial temperature, like the height of the water tower, is not measured from the level at which we can use it, but from the absolute zero of temperature, about 465 degrees below zero Fahrenheit. The most perfect form of heat engine therefore working between a temperature of 390 degrees, or that of steam at 200 pounds pressure, and 60 degrees, the temperature of the atmosphere, could then only have an efficiency of $\frac{330}{855}$ or 38 per cent. It is needless to say that nothing approaching this could practically be realized, not only because such extreme efficiency would be more expensive than the results would justify, but also because any such engine would have to be of a totally different type to the existing steam engine, which cannot work under the conditions demanded for the most economical heat engine. In order therefore to afford a practical working comparison, the definition of an ideal steam engine has been adopted, as follows:—

An Ideal Steam Engine.

"A perfect engine receiving steam at its upper limit of pressure equal to that measured close to, but on the boiler side of the engine stop valve, and continuing this pressure and temperature up to cut-off. Beyond cut-off the steam is assumed to expand adiabatically in the cylinder down to a pressure equal to the back pressure against which the engine is working. The steam is then exhausted from the cylinder at constant pressure corresponding to the lower limit of temperature."

This definition, while it may appear rather complicated, really specifies a perfect steam engine, working as a steam engine does, with steam at boiler pressure and an exhaust pressure determined by conditions, but with perfect expansion and an entire absence of all the losses due to cylinder condensation, compression, and the various other causes which prevent an actual engine from obtaining the greatest possible economy. Such losses are, however, more or less avoidable, and it is the aim of the steam engineer to reduce them by compounding, superheating, and other means, so that the ideal engine thus set up may be fairly taken as a standard which may be approached, although never equaled, by an actual steam engine.

Degree to Which the Locomotive Has Approximated an Ideal Engine.

It is interesting to examine the degree to which the steam locomotive has so far approximated this ideal engine, and for the information in connection with steam locomotives we can use the results obtained in the tests conducted on the testing plant at the St. Louis Exposition in 1904. The conditions under which these engines worked may be taken as a boiler pressure of 200 pounds and an exhaust pressure of 6 pounds, and with these limits the ideal engine would require about 250 b.t.u. per horse power per minute, or 12.8 pounds of steam per hour at boiler pressure. The simple locomotives tested required from 23.6 to 28.9 pounds, while the compounds required from 19.0 to 27.0 pounds, so that compared to an ideal steam engine under the same conditions, the efficiency of the simples was 54 to 44 per cent., and of the compounds 67 to 47 per cent.

The ideal engine taking 250 b.t.u. per horse power per minute, or 15,000 b.t.u. per hour, has an efficiency of 17 per cent. This is obtained by multiplying 15,000 by 778, which gives the work, that is, the equivalent of that amount of heat, 11,670,000 foot pounds, and dividing this into 1,980,000, the foot pounds equal to the work of one horse power hour. As the engines on the testing plant may be said to have had an efficiency of about 50 per cent. for the simples, and 60 per cent. for the compounds, we see that the actual heat efficiency was from 8½ to 10 per cent., based on the total heat delivered to them in the steam, so that even in the case of these particular engines there is 90 to 91½ per cent. of the heat in the coal that cannot be used, that our friend the fireman cannot be blamed for.

Boiler Efficiency.

The efficiency of the engine is, however, only one of the factors determining the proportion of the heat in the coal that can be developed as useful work. The boiler, while not limited by the same conditions as the engine, is still unable to deliver in the steam the full amount of heat that is generated by the coal burned. The losses are, however, nothing like as serious as those that take place in the conversion of the heat in the steam into work, and are only due to the combustion not being entirely perfect, the radiation of heat from the boiler, and to the heat contained in the gases that passes away into the stack. Under favorable conditions the sum of these losses may only amount to about 20 per cent., so that 80 per cent. of the heat developed by the fuel may be actually present in the steam delivered by the boiler. In locomotive practice, however, boilers are not worked under as favorable conditions as are stationary boilers, on account of the enormously larger amount of steam that has to be generated by a boiler of a given size. In place of evaporating 3 pounds of water per square foot of heating surface per hour and burning 15 pounds of coal per square foot of grate, as much as 16 to 18 lbs. of water are evaporated and 120 to 140 lbs. of coal burnt.

This increase in capacity, while necessary in order to obtain

* A paper presented before the November meeting of the Western Canada Railway Club.

the output from a locomotive boiler that would require a whole battery of stationary boilers, is only rendered possible by a sacrifice of economy, or in other words the efficiency of the locomotive boiler is generally considerably less than the 80 per cent. mentioned above. The reasons for this loss in efficiency in the boilers at the St. Louis Exposition were thoroughly investigated by Mr. Lawford H. Fry, and Fig. 1 shows one of the results of the calculations made by him which is exceedingly interesting. It is one of several which he presented in his paper on "Combustion in Locomotive Fireboxes" before the Institute of Mechanical Engineers,* and refers to the trial of the New York Central balanced compound engine No. 3000. The diagrams for the other engines are generally similar, with some exceptions that will be mentioned later.

The efficiency of the boiler, which is shown by the lowest line, is slightly over 70 per cent. when coal is burnt at the rate of 30

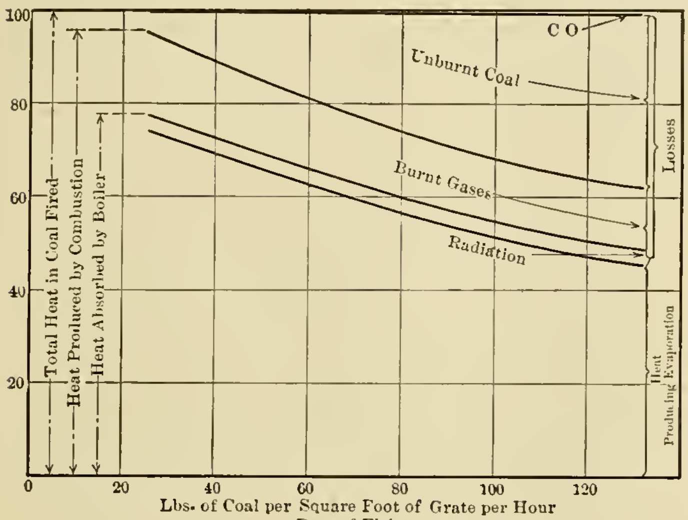


FIG. 1

pounds per square foot per hour, and is gradually reduced to about 46 per cent. as the rate is increased to 120 pounds per square foot per hour. The space between the lowest line and the next above it represents the heat radiated away by the boiler, so that this line shows the total heat absorbed by the boiler from the coal. The space above this represents the heat escaping in the hot gases passing out through the front end, while the space between the two upper lines is the loss from unburnt coal. The loss from imperfect combustion, or from the formation of carbon monoxide, is represented by the space between the highest line and the top of the diagram. This diagram is very interesting. In the first place it shows that at low rates of combustion the locomotive boiler is just as efficient as any, as the line showing the heat utilized would evidently be about 80 per cent. at a rate of 20 pounds per square foot per hour, and in the next place, the losses from imperfect combustion are exceedingly small. This loss was not, however, as small as this in all the engines tested, as in one of them it became about 16 per cent. at the maximum rate of combustion. This is thought to have been due to insufficient ashpan openings and it attracted general attention to that detail of the engine.

On most engines, however, this loss was small, and it is evident that from this cause, there need not be very much loss on a locomotive. It must be remembered that the firing at St. Louis was about as perfect as possible and the running conditions uniform, but from the fact that insufficient air causing a dull fire ran this loss up to 16 per cent. in place of 2 or 3 per cent., it is evident how easily a loss in efficiency may be caused by heavy or intermittent firing which does not keep the fire in a clean, bright condition. The heat wasted by the burnt gases is almost constant. This peculiar fact is due to the decreased amount of air per pound of coal required at the higher rates of combustion, which compensated for the increased temperature at which the gases passed into the front end. The same thing occurs in all the tests and shows how well the fires were kept free from holes and the grates properly and uniformly covered.

The important loss, which increases as the rate of combustion increases, is that from unburnt coal. This loss is not entirely explained. The larger part of it is accounted for by the sparks and coal pulled through the tubes and stack without being burnt, but this is not sufficient to account for the entire loss. The loss from sparks is known to be about 20 per cent. of the total coal burnt, at the highest rate of combustion, and the balance of the loss is accounted for in different ways. Mr. Fry considers a large portion of it is due to unconsumed hydrocarbons, but it is not definitely known whether this is really the correct explanation. It is possible that the line showing the heat loss from the burnt gases should be rather higher, which would decrease the loss shown as unburnt coal. There is also a loss due to good coal shaken down into the ashpan, but with the care taken in carrying out these tests, this also is comparatively small.

All we can say is that after the various known factors have been taken into account, that a portion of the loss due to unburned coal is from an undetermined cause, and that the explanation offered by Mr. Fry is possibly correct, namely, that it is due to unconsumed hydrocarbons passing away into the front end. He considered that this may be produced by the partial distillation of the particles of coal that are carried off the grate by the draft, or that there may be unconsumed free hydrogen in the flue gases. Evidence supporting this view is furnished by the fact that the gas analysis shows more nitrogen than can be accounted for by the other products of combustion, and that if this excess of nitrogen is assumed to be a hydrocarbon gas, the heat contained in it, together with the expected loss by sparks and a reasonable ashpan loss, make up very closely the total loss through unburnt coal. There is here possibly a chance for better economy, that we have hitherto not suspected, but it may be stated that so far as can be learned from the tests, it will not be obtained from the use of a brick arch as it was found that its value consisted in the reduction of the loss by imperfect combustion, due to the formation of carbon monoxide. The engine from which this diagram of heat balances was obtained was fitted with an arch and, as it shows, the loss from carbon monoxide was exceedingly small. On the engines not having a brick arch there was a considerable loss from this cause, amounting to as much as 16 per cent. at higher rates of combustion, and although it so happened that these same engines were subject in each case to unfavorable conditions, there is still good evidence to support the claim made that a properly proportioned brick arch will effect a saving in coal of 5 to 10 per cent.

Efficiency of the Locomotive as a Whole on the Testing Plant.

These points, however, while interesting, do not affect the main information given by this diagram, which it may be stated, is from the most efficient boiler tested at St. Louis. It shows that, under the most perfect conditions of testing, uniform work, economical firing and a boiler in as good condition as possible, the heat accounted for in the steam is from 50 to 70 per cent. of the heat in the coal, as the rate at which the coal is burnt decreases from 110 to 40 pounds per square foot of grate per hour. If this efficiency is combined with that of the engine, which as previously stated varied from 8½ to 10 per cent., we find that the total efficiency of the locomotive, under testing plant conditions, varies from 4½ to 7 per cent., so that we see that the general statement of a loss of 95 per cent. of the heat present in the coal, is confirmed by the best results that have so far been obtained from locomotives.

We also see to what a large extent this loss is unavoidable as long as we are forced to transform heat into work by means of any form of steam engine, and the high degree of perfection that has already been reached by our present locomotives when the limiting efficiency which they could possibly attain is properly considered.

The figures so far discussed have entirely referred to efficiency on the basis of indicated horse power. Before this power reaches

* See American Engineer, May, 1908, page 186.

the rail, it is reduced by the friction losses in the cylinders, motion and axles, and the resultant power is what is termed the dynamometer horse power. Figs. 2, 3 and 4, which are reproduced from the report of the St. Louis tests, show the coal per dynamometer horse power hour for three freight locomotives tested at St. Louis, at forty, eighty and one hundred and sixty revolutions per minute respectively. It will be seen that the most economical results were obtained from No. 585, a Michigan Central cross compound, which at low speeds showed a fuel consumption of only 2¼ pounds per horse power hour. This corresponds to a total efficiency of 7.5 per cent., and is an exceedingly economical result for any type of non-condensing steam engine. As shown on the diagrams the fuel consumption increased at higher speeds, and at 160 r.p.m., which corresponds to 30 miles an hour for a 63 in. wheel, it amounted to 3½ pounds. Fig. 5 shows roughly the coal consumption of these different engines as the speed increased, and is interesting when their varying types are considered.

No. 1499 is a Pennsylvania Railroad simple consolidation, 22 by 28 in. cylinders, 56 in. drivers, 205 lbs. boiler pressure, heating surface 2,844 sq. ft., grate area 49.2 sq. ft.

No. 734 is a Lake Shore & Michigan Southern simple consolidation, 21 by 30 in. cylinders, 63 in. drivers, 200 lbs. boiler pressure, heating surface 2,858 sq. ft., grate area 33.7 sq. ft.

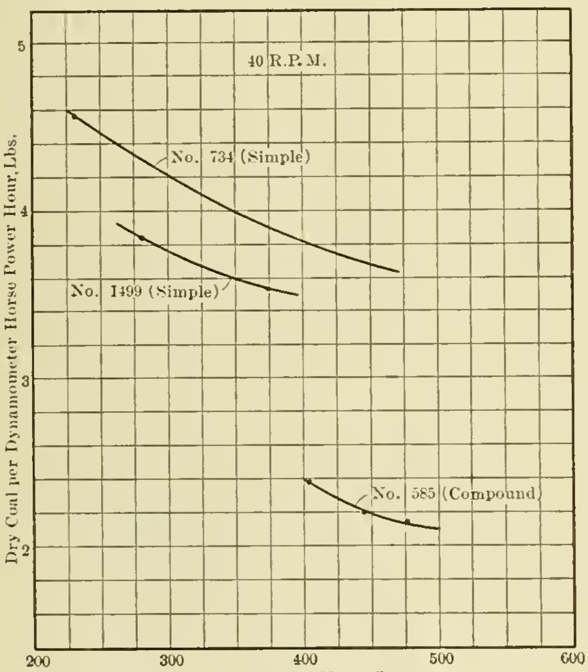


FIG. 2

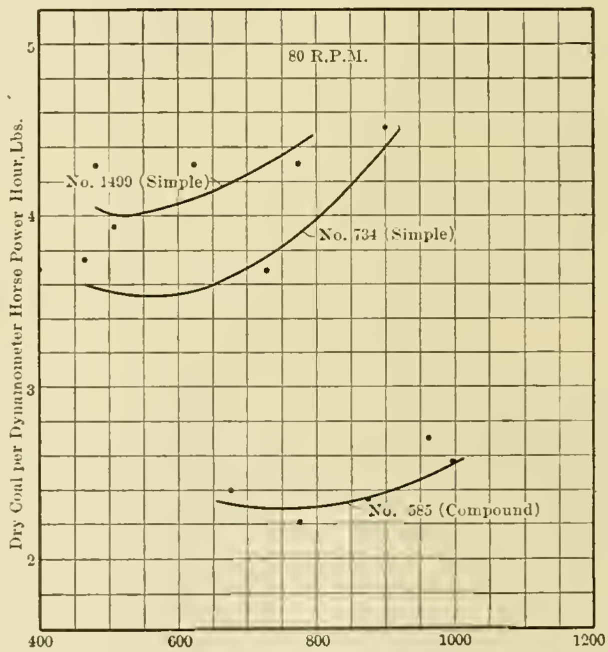


FIG. 3

No. 585 is a Michigan Central compound consolidation, 23 and 35 by 32 in. cylinders, 63 in. drivers, 210 lbs. boiler pressure, heating surface 3,181 sq. ft., grate area 49.4 sq. ft.

The compound engine is evidently far more economical than the simple, but it should be remembered that the conditions in a testing plant are more favorable to this type of engine than are those in regular road service. On the testing plant, they are working absolutely uniformly, everything is maintained as constant as possible during the time the test is conducted, and it is under these conditions, as we know, that the best results from a compound engine can be obtained. The boiler efficiency of No. 585 was also exceedingly good, and in fact a large proportion of the economy is due to this, as No. 734 showed only from 70 per cent. to 82 per cent. of the boiler efficiency of 585, and that of engine 1499 showed very poor results at the higher rates of evaporation, due to the insufficient air supply. Still while there may be reasons why the simple engines showed so much greater fuel consumption than the compound, there are no reasons why the compound should show more, and the fact remains that a steam locomotive under the best conditions, has developed a dynamometer horse power hour at a coal consumption of 2¼ to 3½ pounds, corresponding to a total efficiency of 4.9 to 7.5 per cent.

Actual Efficiency of Locomotives in Service.

We have found therefore that in order to realize what are avoidable and what are unavoidable losses in the conversion of heat into work by a steam engine or locomotive, that it is necessary to consider first what degree of economy could be obtained by an ideal steam engine working under certain limiting conditions, and then consider with what perfection our existing locomotives approach that ideal. Locomotives do not, however, operate upon testing plants, but in hauling trains, and the real point we are interested in is the extent to which our locomotives in actual service approach the best results that it is possible to obtain. We know that on the testing plant the machinery was in the best possible condition, the boiler was not leaking, the valves and pistons were as tight as they could be made, and the firing was as good as it could possibly be. To what extent do we approximate the testing plant results and how does our actual efficiency compare with that obtained upon them?

Unfortunately when we are dealing with road conditions there are a number of factors to be considered that cannot be accurately allowed for. In place of constant conditions there are exceedingly variable ones; part of the time the engine is running and part of the time standing, and any comparison that can be made must necessarily be more or less approximate. No estimate can be made that is a reasonable one for determining the exact consumption of the engines in pounds of coal per dynamometer horse power hour, but one figure can be obtained with reasonable accuracy, namely, the efficiency of the equipment and organization as a whole. If in place of the ideal steam engine we consider the best results obtained upon the testing plant as the ideal locomotive efficiency, we can determine fairly closely the degree to which such an ideal is approached by our locomotive and operating departments. To do this some particular section or division must be selected, and for this purpose I will refer to the results obtained on District 1 of the Central division on the Canadian Pacific Railway during the last few months. On that district the fuel consumption has for several months been below 80 pounds per thousand equivalent gross ton miles. In one month it was 75 and in another 76, and these figures are not taken from any particular test but represent the total consumption on the division, averaging over 7,000 tons of coal per month. When it is considered that, although the difference in level of the two ends of this division of 420 miles is small, only 150 feet, the heavier tonnage is uphill, it is doubtful whether this result has ever been equaled in this or any other country, especially where the large amount of traffic which it includes is taken into account. It is therefore a good example to consider for comparison with an ideal engine, but on account of the hill condition on the east end, the section from Ignace to Winnipeg is preferable in place of the entire district.

The coal records available on the road show the total coal consumed per 1,000 equivalent gross ton miles, and cannot therefore be directly compared with the coal per dynamometer horse power hour. Supposing, however, a train had an average resistance over a division of five pounds per ton, so that 1,000 tons gave a resistance of 5,000 pounds. This 5,000 pounds pulled one mile, or 5,280 feet, would equal 26,400,000 foot pounds. A horse power hour is 1,980,000 foot pounds, so that 1,000 ton miles with a train having a resistance of 5 lbs. per ton is the equivalent of 12.8 horse power hours. This is evidently proportional to the resistance, so that if the average resistance of the train was 10 lbs. per ton, 1,000 ton miles would equal 25.6 horse power hours and so on.

I cannot give the exact figure for the resistance of a train from Ignace to Winnipeg, but the figure obtained for a very similar

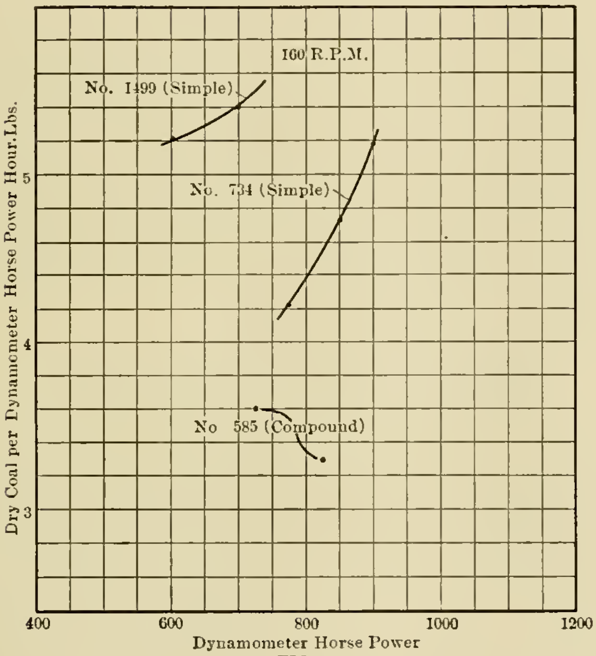


FIG. 4

district, Outremont to Smith Falls, was 4.50 lbs. eastbound and 7.00 pounds westbound. The difference in level is 2.6 feet per mile which accounts for 1 lb. per ton from an average of 5½. From other figures we have I believe the figures of 7 lbs. per ton is slightly high and that figure for a level undulating road with short grades not exceeding 0.5 or 0.6 per cent. would be about 5½ lbs. The difference in level would increase this to 6½ lbs. up hill and reduce it to 4½ lbs. down. Now from Ignace to Kenora the grade averages 2.7 feet per mile down westbound, and from Kenora to Winnipeg 2.53 feet per mile down westbound, so that with very little danger of inaccuracy we may say that the average resistance is 4½ lbs. per ton west and 6½ lbs. per ton east bound on these two sections. One thousand ton miles is therefore the equivalent of 11.5 and 16.6 horse power hours respectively, and if we assume that when working, the ideal engine has a speed of 20 miles per hour corresponding to a coal consumption of 2.7 lbs. per dynamometer horse power hour, the coal required per 1,000 E. G. ton miles would be 31 and 44½ respectively.

Taking the month of July this corresponds with *actual results of 61 and 86½ lbs., or an efficiency of 51 per cent. in both cases, and this in a sense may be said to be the efficiency of the operation as a whole.* This, however, is not exactly fair, it does not mean that the ideal engine could possibly do the work on 51 per cent. of the coal. On the testing plant, the fire is in good condition when the test is started and finished, the engine does not have to turn a wheel except the drivers, there are no air pumps or electric headlights to run, while on the road every pound of coal has to be accounted for, and the resistance of the engine is, even when the machine friction is deducted, certainly equal to that of the train. Suppose we consider our ideal engine under these conditions. The average length of the sections is 139 miles, the amount of coal lighting up, and that which must be knocked out at the end of the run, is about 2,000 lbs. If we assume that the average length of trip is 10 hours and the air pump takes 30 double strokes a minute during that time, on a full train, the air pump will take about 2,000 lbs. of coal westbound, and 1,100 lbs. eastbound. The headlight requires 60 lbs. of coal per hour and if burned 6 hours out of 24, or 25 per cent. of the time, will average 150 lbs. per trip. We have therefore 4,150 lbs. westbound and 3,250 eastbound per trip required by the road engine, or 30 and 23 lbs. per mile respectively. We have in addition to allow for the power required to draw the weight of the engine, so that making these allowances the coal required by an ideal engine would be as follows:—

Westbound.	Per 1000 ton miles for actual power developed......	31. lbs.
	Additional for weight of engine....................	2.1 lbs.
	Additional for air pump, etc.......................	13.9 lbs.
	Total	47.0 lbs.
Eastbound.	Per 1000 ton miles for actual power developed......	44.5 lbs.
	Additional for weight of engine....................	5.3 lbs.
	Additional for air pump, etc.......................	18.8 lbs.
	Total	68.6 lbs.

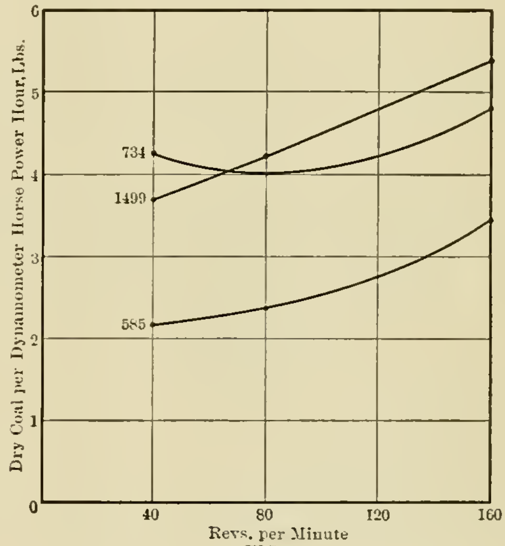


FIG. 5

The net efficiency obtained therefore is 77 per cent. and 79 per cent. respectively, or considering the roughness of this calculation, about 75 to 80 per cent. This appears to be a very creditable record. We do not, of course, know whether the engine is as economical as that at St. Louis, but we have had almost exactly similar engines on this road and have found that under favorable conditions their economy is practically the same as that of the D 10 class which were in use on this district, while under other conditions the D 10 were superior. We may safely say, therefore, that this district has come within 25 per cent. of testing plant conditions, so far as we know them, and to you gentlemen, members of this club, who are also engaged in this work, I can only say that you have done well, but let us get after that other 25 per cent.

Train Despatching by Telephone.—The Norfolk & Western will soon have telephones in use for train despatching throughout its main line from Norfolk, Va., to Columbus, Ohio, about 700 miles. On some divisions the telephones have been in use many months and the others are to be equipped soon.

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INFORMATION CONCERNING NEW EQUIPMENT ON A RAILROAD.

When a new type of locomotive or car is purchased and placed in service on a road the men in charge of its operation, maintenance and repair usually have considerable difficulty in getting information from headquarters as to its design or special features; this often results in mistakes being made which sometimes prove expensive and oftentimes a feature of special merit is condenmned because its use has not been fully understood and it has been misused or not used at all.

One of the most enthusiastic supporters of this journal dates his first interest in it from a time ten years or more ago when he was general foreman of a repair shop, because by its aid in an emergency he was able to make a record in repairing and placing back in service a new type of locomotive which had just been received on his division and had been injured in a wreck. He was unable to secure drawings of the locomotive from the mechanical engineer's office, which was located on another part of the system, but fortunately found the information that he required in connection with a description of the locomotive in a copy of the AMERICAN ENGINEER, that had just been received.

Realizing the importance of having the engineers, firemen, shop men, roundhouse men and mechanical department officials well posted as to new types of power, the Union Pacific Railroad Company, in connection with its Educational Bureau of Information, has issued an instruction pamphlet to these men describing quite completely the new articulated compound locomotives which have just been placed in service on that system. In addition to photographs and general drawings of the locomotives a number of the more important details, which are not standard on other types of locomotives already in service, are illustrated by line drawings. It is believed that this is the first time such information has been issued to the men by a railroad before or even after the locomotives have been placed in service. It will surely prove of great benefit.

WELFARE WORK ON THE RAILROADS.

Many of the railroads have given much study and expended considerable sums in improving the conditions surrounding their employees and in establishing pension systems. Of interest from this standpoint, at least to some extent, are two booklets that have been received during the past month. One of these, entitled "Welfare Work," is from the Canadian Pacific Railway and explains in an interesting and readable manner how that company is helping to improve the strength of its organization, by bettering the conditions under which its men have to work, by educating them so that they will be of greater service and fit themselves for more important positions in the organization and by its pension system. An abstract of this will appear in our next issue. Another booklet is from the Grand Trunk Railway and is entitled "Training Modern Mechanics—How a Great Railroad Has Solved the Problem." It describes in detail the apprentice system on that road which was also described in an article in this journal, page 21, January, 1908. Both of these booklets are very attractively arranged and are splendidly illustrated and printed.

Announcement is made in this issue of the pension system about to be installed upon the New York Central Lines and of the increase in the amount of the minimum pension on the Chicago and Northwestern Railway. The Rock Island System will establish a similar pension system with the opening of the new year. The educational bureau of information on the Union Pacific Railroad, although only established a few months ago, promises splendid results; the work of the apprentice department on the Santa Fe has been extended to include all of the apprentices on the system, as will be seen in a note on another page. The New York Central Lines will within the next few months finish the first four years under which the improved apprenticeship system has been in force and the results thus far are greater than had been anticipated in so short a time, even by the most enthusiastic supporters of the scheme.

These few items, noted not because they cover the field, but rather because they have been drawn to the attention of the editors in one form or another within the past few days, are an indication of how the railroads in general feel about these questions and indicate the direction in which the current is flowing. They give a promise of greater efficiency among the railroad employees and the upbuilding of a spirit of loyalty and co-operation that will mean much from an economic standpoint in the years to follow.

A STITCH IN TIME.

Weather of the character that swept practically the whole country during the latter part of the last month brings the value of first-class locomotive terminal facilities forcibly to the attention of every official and indeed to every patron of our railroads. It is at such a time that the millions invested in first-class structures and equipment return a very high rate of interest and it is for coping with just such periods of great difficulty in operation that locomotive terminals should be designed in every detail.

In this issue appears the first part of an extensive discussion of this subject, which will be continued in the two following numbers. This seems to be a very opportune time for bringing this matter up for discussion and it is to be hoped that a practical improvement will follow its agitation.

Under severe winter conditions which have to be met, usually for several months, in the northern section of the United States, which includes a very large proportion of the total mileage of the country, the locomotive terminal facilities are in reality the keystone of the complicated structure of railroad operation and any looseness at this point affects the stability of the whole structure. In view of this it is easily recognized that roundhouses, cinder pits, intercommunicating facilities, etc., should all be designed so as to successfully meet the worst possible conditions, although they may be put to the supreme test for but a few weeks out of the whole year. Yet it is in those few weeks that their value will be large enough to pay interest on the investment for the whole period. At times when schedules are thoroughly disarranged, tonnage is reduced, the efficiency of the personnel of both shop and road are reduced, derailments are numerous and nerves are frayed, *then* a smooth working, competent roundhouse organization provided with suitable tools, proper protection and convenient arrangement, is worth anything it may cost, no matter how large.

This whole subject should also be seriously considered at this time when appearances indicate that the articulated type of locomotive will become more or less common. It will be remembered how much confusion was caused at division terminals when the Pacific type engines were first introduced and how the whole scheme of terminal operation was handicapped by their very large size and great length. That experience will be duplicated in a much more aggravated form if the Mallets become common and careful consideration of this possibility should be given in connection with the redesign of any division points.

The second principle advanced for the most successful conduct of a motive power department in the June, 1909, issue was, "Establish a standard cost or allowance for each of the various items of expenditure and see that it is not exceeded." This principle applies to the expenditure for fuel fully as much as it does to any other item and elsewhere in this issue are given two very complete discussions of the theoretically and practically possible limits of fuel consumption. There are probably none better fitted to speak on this subject than the authors of these papers and the information contained therein will undoubtedly be found to be of great value for establishing a satisfactory new standard or checking up the present one.

EDUCATIONAL BUREAU OF INFORMATION.

Union Pacific Railroad.

An outline of the work of the educational bureau of information, recently established on the Union Pacific Railroad, appeared in the October, 1909, number of this journal. In discussing this matter at the fourth annual meeting of the operating officials, D. C. Buell, chief of the bureau, explained the work of the bureau in greater detail. Following is an abstract of his remarks:

Assisting Employees to Assume Greater Responsibilities.

All practical railroad men realize that much of their work is governed by what may be termed unwritten laws. Few books are published that give practical information of value concerning it, and many employees are so situated that it is impossible under present conditions to acquire a working knowledge that will fit them to assume greater responsibilities. You gentlemen have had the perseverance to work out your own betterment; have used your eyes, ears and brains to learn all you could of the reasons for doing things that were going on around you daily, and by your fitness have overcome your difficulties and risen to your present official positions, but who can tell how much hardship and how many mistakes might have been avoided had you had the opportunity to learn much of this unwritten law, gleaned from the experience of, and put in practical form by, those who had "gone through the mill" before you.

It is the purpose of this bureau in its first object to furnish courses of reading and study especially prepared under the direction of the advisory board to cover as much of this so-called unwritten law as possible and to combine with it such existing instructions and written matter as will assist an employee to assume greater responsibilities in the line of his work, the course to be conducted somewhat on the method of now existing correspondence schools.

The privilege of taking a course of this kind is offered to all employees. The bureau will offer any employee desiring to qualify himself to assume greater responsibilities, a course of reading and study along the line that he may indicate. This course need not necessarily be confined to the particular work of the department with which the employee is connected, but may embrace any subject, the knowledge of which may be of value to the employee in the position now occupied or that will help to qualify the employee to change positions to a line of work which would be more nearly suited to the ambition or desire. This statement was made broad enough so that no employee need hesitate to state what he wanted the bureau to do for him or what line of work he was ambitious to master. Certain reasonable qualifications, however, are implied, and these are concisely set forth as follows:

Firemen, until they have passed promotion examinations in rules, air brake and machinery, will be assisted only on matters pertaining to the knowledge necessary to pass these promotion examinations.

Brakemen, switchmen, etc., until they have passed all promotion examinations for conductors, yard foremen, etc., will be assisted only by answers to such questions as they may ask the information bureau, although we do not limit the number of questions they may ask. An exception to this will be made in the case of brakemen having had three years experience, or more, one year at least of which has been served on the Union Pacific Railroad, in which case an advanced course may be taken up with the permission of the general superintendent.

Stenographers, clerks, etc., will be allowed to take up studies pertaining to the department in which they work as long as they are not of too advanced a character, and in special cases where they are anxious to get into a different line of work they may be allowed to take up a study of work in other departments, by the approval of the general superintendent.

It is not the intention to teach elementary or rudimentary subjects, such as arithmetic, writing, spelling, grammar, etc., which are taught in ordinary night schools or business colleges, except in certain particular cases, such as shop classes for apprentices, or where an employee is located at such a point that there is no other way for him to get this training, and the training of this man in the particular subject would be of benefit to the company.

In planning the different courses now in preparation it was thought best to require each student to familiarize himself with the history of the Union Pacific, its geography and resources, and to also give an outline of the federal and state laws that affect the road. In all cases this will probably be the first work of the different courses.

Courses are now being prepared on the maintenance of automatic block signals, mechanical engineering as applied to railroad work, track work in both English and Japanese, station work, freight traffic, accounting, railroad operation, electric lighting and power, questions and answers for firemen studying for promotion examinations in machinery.

Additional courses planned are: Gasoline motor car work, analysis of statistics, maintenance of interlocking plants and their construction, car building, shop practice, civil engineering as applied to railroad work, refrigeration.

The courses now being prepared all start with the elementary work and lead up step by step so as to give a general practical knowledge of the subject. Students assigned to these courses will be started on the first work and while it will be in the nature of a review for some of them, it is hoped they will all profit to some extent by a study of this elementary work, thus insuring a thorough knowledge of the subject as they progress, and that they will have patience with the bureau until the more advanced work can be gotten out. The first work was sent out about November 1st.

Where special courses are asked for, the applications will be considered by the advisory board and the course furnished, if practical, at as early a date as possible. The lessons will be sent out to students in two forms. First: Lessons that have been specially prepared by the bureau will be mimeographed on standard letter-size paper with cloth binding, and the student may keep these. Second: Instructional matter to be studied from books already printed will be outlined, showing just what parts of the printed work must be mastered, and this outline sent to the student with the book. These books will simply be loaned to the student, and he will be held responsible for their safe return, and in case of failure to return them, they will be charged against him at cost price. The books may be kept a reasonable time, the student being notified as to when he should return them. An extension of time will be allowed for good cause.

A set of questions will be sent with each lesson. Written answers must be submitted and show a satisfactory understanding of the work before additional lessons will be furnished. Students must show interest in their work by doing a reasonable amount of studying. They will not be crowded, but lapses of several months without reasonable excuse will be considered sufficient grounds for dropping them from the student rolls.

Applications from employees are numbered consecutively as received and a blank form sent out to be filled in with information as to the education and practical experience of the applicant, together with a statement as to whether he has made a special study of any subject, is a subscriber to any technical magazine, or a student of a correspondence school. He is also asked to state what he desires the bureau to do for him, the information he wants, what line of work he wants to advance in, and what (in reason) he is ambitious to become. This application, when complete, is considered by the advisory board, and if the information requested is of the proper sort, the course is assigned. If, however, the request is such that any of the qualifications above noted are in effect, then further correspondence is had with the applicant until something can be assigned that is satisfactory to both the applicant and the advisory board.

Men selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the board of supervisors. Complete records will be kept of the student work done by employees.

Increasing the Knowledge and Efficiency of Employees.

Rarely a day passes in the course of a busy man's career but that some question comes to his mind about which he would like information. The majority of such questions, however, go unanswered unless some pressing necessity makes it imperative that time be taken to obtain the answer. Workmen hesitate to ask too many questions of their foremen; foremen let some point go rather than to show their lack of knowledge and some officials even clothe their lack of knowledge on occasional points in the mantle of reserve rather than to risk their official dignity by asking a question of a subordinate who assumes their knowledge to be universal. Many questions that are asked are answered in such a way that the questioner does not understand the point clearly and rather than to appear dull or slow, the matter will often be dropped.

It is the purpose of this bureau in its second object to provide a means whereby any employee desiring information on any particular question or problem met with from day to day, can send this question to the bureau for an answer. There is no formality connected with this matter; all that is necessary is to write the question and mail it to the bureau, giving name and address where employed, also position or occupation. The information will be furnished through the bureau in a simple and practical manner and as promptly as possible. The bureau will have its own telegraph office and officials can get information direct by wire, using cipher code if desirable.

Questions, when received, are copied and referred to the member of the advisory board best qualified to answer them, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas or precedents of the department to which they relate. The answers are held and passed on by the advisory board at the first meeting and are then sent to the questioner. It is not the intention to have questions requiring the official ruling of some particular person sent to the bureau, but if such questions are received it is the intention to handle them through the bureau, having the proper member of the advisory board send them to the proper official for a ruling, after which they are returned to the bureau. In cases of this kind the questioner, when his answer is returned, will be requested to refer such matters through the regular channels in the future.

All questions are handled impersonally; the name of the questioner is not shown on the question when it is passed to the advisory board member for handling, only the questioner's occupation being given; nor is the name of the advisory board member furnishing the answer shown. No limit is set on the number of questions that may be asked and an employee may ask for information every day if he so desires. A record is kept of all answers, catalogued for easy reference, and a card catalogue shows which of the employees are taking advantage of this branch of the bureau.

Preparing Prospective Employees for the Service.

The promotion of desirable men and the elimination of undesirables creates a constant demand for new material throughout the organization. The demand is perhaps greatest for station helpers, signal men, operators, freight house men, agents, clerks, brakemen, common laborers.

It is the purpose of this bureau to assist in supplying men of good reputation and character for vacancies of this order, and where possible to train these men as far as practical in the duties of their prospective work before their employment. To this end, applications for employment will be received, preference in all cases being given to dependents or relatives of employees. The personal history of all applicants will be obtained, references investigated, and each applicant required to take a physical examination to assure us that he can pass our requirements, if his record is satisfactory and we wish to employ him. The names of all available applicants will be kept on file at the bureau and any official wishing help can apply to the bureau for it. If satisfactory material is on hand it will be furnished immediately.

The bureau, however, will not solicit positions for applicants; requests will have to come from the general organization if its assistance is desired, and the interest of the bureau in the men furnished ceases when they are employed, unless later they take advantage of the privilege of the information or educational features. Applications of experienced railroad men, when received, will also be looked up and their names placed on file, although it is hoped that all positions suitable for men of this class can be filled from our own ranks.

The names of student employees making marked progress in their studies will be placed before the general superintendent for his information, and it is hoped that in this way men available for promotion will have a better chance to connect with vacancies that they may be qualified to fill, and thus the necesssity for going outside our ranks to fill such positions be still further reduced. Where practical to do so, the elementary lessons of suitable courses may be sent to applicants whom we think we will have use for in the future, so that they can be preparing themselves to give better service when employed.

In addition to the foregoing, there will be established under this third object, schools at the Bureau's offices, for the preparation of student operators, brakemen and signal service men by personal instruction. Students of telegraph schools preparing for positions as student operators will, on graduation from their course in telegraphy, be brought to Omaha and put through a course of training of from two to four weeks in a model local station fitted for this work. This station will be equipped with the regular local station furniture and forms, wires will be cut into an operator's table; tariffs, tickets, baggage checks, time cards, etc., will be used to familiarize these students with the actual work they will have to do when they go in service, and an instructor will direct their work and see that they have the knowledge necessary to give satisfactory service before they are sent out.

The training of applicants for positions as brakemen is a more difficult proposition, but it is hoped that men can be taught the operating and block signal rules, the signals, how to pack hot boxes, and care for their markers and lanterns. In addition to this, and probably most important, there will be instilled into them the knowledge that honesty, sobriety, careful attention to duty and the observance of all rules and regulations will assure them of a steady job and the right to hope for future promotion.

The training of applicants for positions in the signal department will be accomplished by actual work on batteries and signal appliances, installed as a part of the school's equipment, and while this school in these branches will be experimental, there is reason to hope that the experiment will be a success, as proved by better material furnished due to its establishment.

THE UTILIZATION OF FUEL IN LOCOMOTIVE PRACTICE.*

By W. F. M. Goss.

Introduction.

The locomotives in service on the railroads of this country consume more than one-fifth of the total coal production of the United States. The amount is so large that any small saving that can be made effective in locomotive practice at once becomes an important factor in conserving the fuel supply of the nation. For this reason the United States Geological Survey has given attention to the special problems of combustion in locomotive boilers. It has approached this task from several different directions. The facts presented herewith constitute one series of results.

In the fall of 1906 the locomotive-testing laboratory of Purdue University, at Lafayette, Ind., entered on a series of tests, one purpose of which was to determine in precise terms the degree of efficiency with which a modern high-class American locomotive utilizes the heat energy of the fuel supplied to it. The general interest in the subject, the elaborate plans which had been formulated for conducting the work, and the substantial character of the support which had been pledged to maintain it justified the Geological Survey in aiding the investigation. The co-operation of the Survey consisted in detailing experts to assist the regular staff of the laboratory in the chemical and calorific work of the tests. These experts, working under the general supervision of the director of the Purdue laboratory, became responsible for the sampling of smoke-box gases, of the fuel used, of the cinders caught in the front end, of the sparks discharged by the stack, and of the refuse caught in the ash pan. The gas analyses were made by them at the university laboratory. The analyses of all solid samples and the calorific tests of the fuels were made at the government fuel-testing plant at St. Louis. The representatives of the Survey were not concerned with other phases of the work.

The locomotive used in the experiments is a simple superheating locomotive of the American type, with a boiler designed to operate under pressures as high as 250 pounds. The superheater is of the return-tube type and was built and installed in the summer of 1906.

Some of the principal characteristics of the locomotive are as follows:

Total weight	109,000 lbs.
Weight on four drivers	61,000 lbs.
Cylinders:	
Diameter	16 in.
Stroke	24 in.
Drivers, diameter outside of tire	69¼ in.
Boiler:	
Type	Extended wagon top
Length of firebox	72 1/16 in.
Width of firebox	34½ in.
Depth of firebox	79 in.
Number of 2-inch tubes	111
Number of 5-inch tubes	16
Length of tubes	11½ ft.
Heating surface in firebox	126 sq. ft.
Heating surface in tubes, water side	897 sq. ft.
Total water-heating surface, including water side of tubes	1,023 sq. ft.
Superheater:	
Type	Cole return tube
Outside diameter of superheater tubes	1¼ in.
Number of loops	32
Average length of tube per loop	17.27 ft.
Total superheating surface based upon outside surface of tubes,	193 sq. ft.
Total water and superheating surface, including water side of boiler tubes	1,216 sq. ft.

The purpose of the tests was to determine the performance of the boiler and superheater of a normal locomotive while developing such rates of power as are common in locomotive service. The process involved a careful study of the various channels through which the heat energy of the fuel is absorbed or dissipated.

The results represent work done with two grades of coal that will be designated as coal A and coal B. Both are of excellent quality. The greater part of the tests were run with coal A, which, for purposes of discussion, will be regarded as the standard for the tests. The chemical characteristics and the calorific value of samples taken from the fuel of each test are summarized in the following table:

	Coal A.	Coal B.
Moisture, per cent.	1.89	3.10
Volatile matter, per cent.	31.94	15.23
Fixed carbon, per cent.	57.71	72.75
Ash, per cent.	8.46	8.92
Heating value per pound of dry coal B.t.u.	14,047	14,347
Heating value per pound of combustible, B.t.u.	15,372	15,802

Heat Balances.

Heat balances representing the action of locomotive boilers have justly been regarded as difficult to formulate. In the present tests efforts were made to procure complete data on which such a balance could be based. The data making up these balances are presented in Figure 1, but can be most easily understood by reference to Figures 2 and 3, which show the results obtained with coal A and coal B, respectively. It is the purpose of the heat balance, as the term implies, to account for all heat represented by the coal supplied to the fire box, not only the heat which is utilized, but that which is lost, and to point out the various channels through which losses occur. In the diagrams the term "heating surface," as applied to the abscissas, includes the heat-transmitting surface of both boiler and super-

* Extracts from Bulletin No. 402, U. S. Geological Survey.

No. of test.	Laboratory designation.	Calorific value (British thermal units per pound of combustible).	British thermal units absorbed per pound of combustible fired.	British thermal units lost per pound of combustible fired.									Percentage of heat—									
				Due to H_2O in coal.	Due to H_2O in air.	Due to H_2O formed by H in coal.	Due to escaping gases.	Due to incomplete combustion.	Due to front-end cinders.	Due to stack cinders.	Due to refuse in ash pan.	Unaccounted for.	Absorbed by boiler and superheater.	Due to H_2O in coal.	Due to H_2O in air.	Due to H_2O formed by H in coal.	Due to escaping gases.	Due to incomplete combustion.	Due to front end cinders.	Due to stack cinders.	Due to refuse in ash pan.	Unaccounted for.
1	2	85	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
1	30-5-240......	15,388	9,040	24	70	632	1,975	576	1,235	141	639	1,056	58.75	0 16	0.46	4.11	12.83	3.74	8.02	0.92	4.15	6.86
2	40-4-240......	15,416	9,136	24	33	625	2,057	565	1,224	147	537	1,068	59.28	.15	.20	4 05	13.35	3.67	7.94	.95	3.48	6.93
3	30-4-240......	15,398	9,252	25	82	633	2,049	451	886	137	933	950	60.08	.16	.53	4.11	13.31	2.93	5.75	.89	6.06	6.17
4	30-2-240......	15,352	10,189	41	39	688	2,087	72	432	205	634	965	66.37	.27	.25	4.48	13.58	.47	2.81	1.34	4.13	6.30
5	40-6-200......	15,566	9,832	28	62	649	2,325	243	918	173	588	748	63.16	.18	.40	4 17	14.93	1.56	5.00	1.11	3.78	4.81
*6	50-4-200......	15,744	8,489	34	55	544	2,133	66	1,882	284	823	1,434	53.90	.22	.35	3.45	13.32	.42	11.96	1 80	5.23	9.37
7	40-4-200......	15,214	9,330	29	75	671	1,801	746	750	206	895	711	61.34	.19	.49	4.41	18.86	4.90	4.95	1.35	5.88	4.63
8	30-6-200......	15,332	9,552	23	47	637	2,297	167	625	124	785	1,075	62 34	.15	.31	4.16	14 98	1.09	4 08	.81	5.12	6.96
*9	30-2-200......	15,875	10,430	56	58	541	2,392	8	670	243	738	739	65.70	.35	.37	3.41	15.07	.05	4.22	1.53	4 65	4.65
10	30-8-160......	15,425	10,209	25	42	653	2,342	195	561	112	570	716	66.16	.16	.27	4.24	15.18	1.27	3 64	.73	3.70	4.65
11	40-6-160......	15,351	10,170	34	42	646	2,272	229	463	205	604	686	66.25	.22	.27	4 21	14 79	1.49	3 02	1.33	3.93	4.49
12	30-4-160......	15,300	10,575	28	57	581	2,160	194	178	152	573	802	69.12	.18	.37	3.80	14 11	1.27	1.16	.99	3.74	5.26
*13	40-12-120.....	15,857	7,408	45	55	556	2,217	199	2,654	596	445	1,680	46.72	.28	.35	3.51	13 98	1 26	16.74	3.76	2 81	10.59
*14	30-14-120.....	15,714	7,456	54	44	568	2,272	122	2,373	817	446	1,562	47.45	.34	.28	3.61	14.46	.78	15 10	5 20	2 84	9.94
*15	30-10-120.....	15,799	8,480	43	43	547	2,178	116	1,910	326	948	1,208	53 67	.27	.27	3.46	13.78	.73	12 09	2.06	6.00	7.67
*16	40-8-120......	15,752	9,446	42	44	538	2,294	30	1,233	320	665	1,140	59.97	.26	.27	3.42	14 56	.19	7 82	2 03	4.22	7.26
17	30-8-120......	15,348	10,701	34	59	597	2,239	130	270	132	439	747	69.73	.22	.38	3 89	14.58	.85	1.76	.86	2.86	4 87
*18	40-4-120......	15,872	10,817	55	46	486	2,145	89	400	174	807	833	68.14	.35	.29	3 06	13.58	.56	2.52	1.10	5.09	5.31

FIG. I.

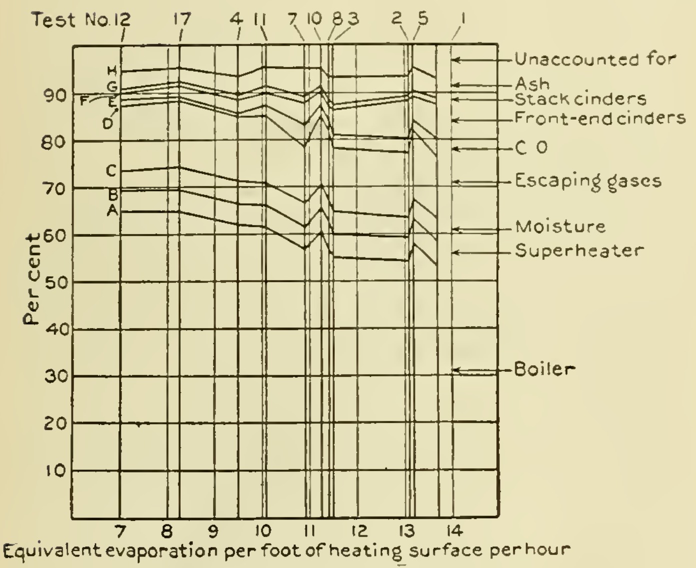


FIG. 2.—RESULTS OBTAINED WITH COAL A.

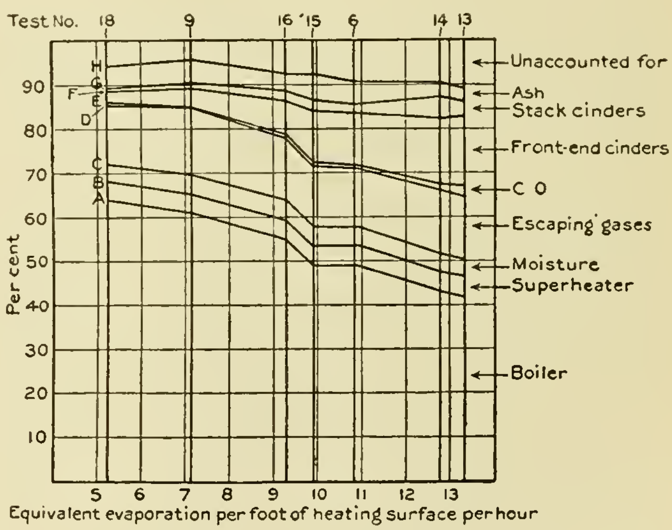


FIG. 3.—RESULTS OBTAINED WITH COAL B.

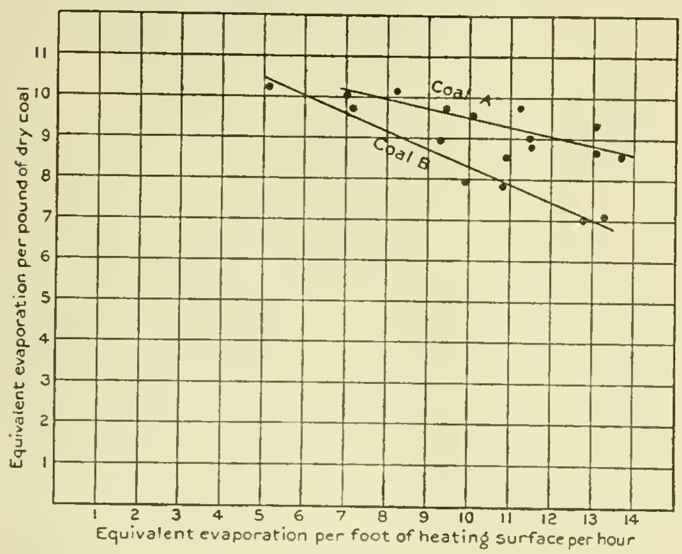


FIG. 4.

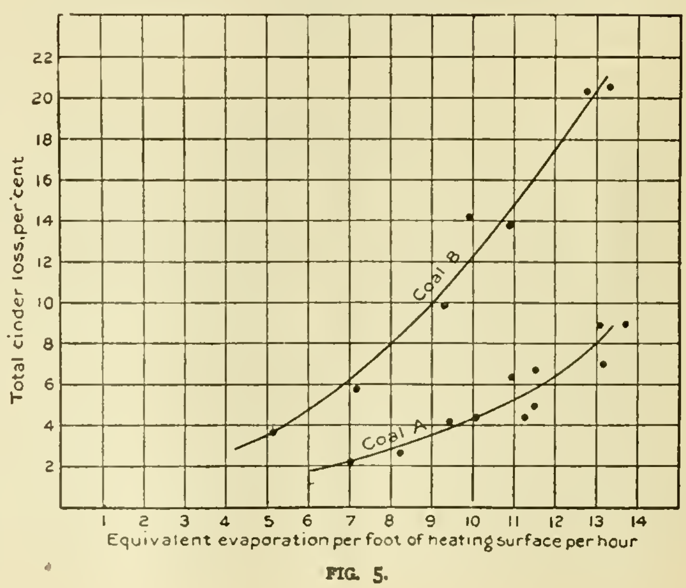


FIG. 5.

heater. The ordinates of the diagrams represent the percentage of heat in the fuel supplied. Distances measured on ordinates between the axis and the first broken line, A, represent the percentage of the total heat supplied which is absorbed by the water of the boiler. The line A is, in fact, a definition of the efficiency of the boiler under the varying rates of evaporation represented by the tests. Though based on a different unit, it is, as it ought to be, similar in general form to the lines defining the evaporative efficiency of the boiler in terms of pounds of water evaporated per pound of coal used (Fig. 4). The inclination of all such lines shows the extent to which the efficiency of the boiler suffers as the rate of evaporation is increased. The nature and extent of the losses leading to decreased efficiency are to be found in the areas above the line A. The fact that the points representing different tests through which this line is drawn do not result in a smooth curve is due to irregularities in furnace conditions that were beyond the vigilance of the operator, an explanation which applies equally to other lines of the same diagram. Again, where the points on which the line A is based fail to form a smooth curve, the reason therefor is to be found in the location of the lines above.

The percentage of the total heat which is absorbed by the superheater is measured by distances on ordinates between lines A and B. It is apparent that this quantity is practically constant, whatever may be the power to which the boiler is driven; that is, this superheater is a device of constant efficiency. The normal maximum power of a locomotive may for present purposes be taken as represented by an evaporation of 12 pounds of water per square foot of heating surface per hour. At this rate the superheater, which contains 16 per cent. of the total heat-transmitting surface, receives approximately 8 per cent. of the total heat absorbed. Distances between the broken line B and the axis represent the efficiency of the combined boiler and superheater, and distances above the line B account for the various heat losses incident to the operation of the furnace, boiler, and superheater.

Losses of heat arising from the presence of accidental and combined moisture in the fuel, of moisture in the atmospheric air admitted to the fire box, and of moisture resulting from the decomposition of hydrogen in the coal are represented by distances measured on ordinates between lines B and C. It is of passing interest to note that the heat thus accounted for is practically equal to that absorbed by the superheater.

Losses of heat in gases discharged from the stack are represented by distances measured on ordinates between lines C and E. The distances between lines D and E represent that portion of these losses which is due to the incomplete burning of the combustible gases. The record shows that the stack loss (C-E), while necessarily large, increases with increased rates of combustion far less rapidly than has been commonly supposed. In other words, the loss in evaporative efficiency with increase of power (line B, Figs. 2 and 3) occurs only to a very slight degree through increase in the amount of heat carried away with the smoke-box gases. That portion of this loss which is chargeable to incomplete combustion (CO) is small under low rates of combustion (Column 104, Fig. 1), but may increase to amounts of some significance under the influence of very high rates of combustion, as will be seen from the record of coal A.

Losses of heat through the discharge from the fire box of unconsumed fuel are represented by distances measured on ordinates between lines E and H. The loss thus defined is separated into three parts—the heat loss by partly consumed fuel in the form of cinders collecting in the front end (E-F), the heat loss by partly consumed fuel in the form of cinders or sparks thrown out of the stack (F-G), and the heat lost by partly burned fuel dropping through the grate into the ash pan (G-H). The first two of these losses increase with the rate of power developed. They are, in fact, the chief cause of the decrease in the evaporative efficiency of a locomotive boiler with increased rates of power. This is well shown by a comparison of the two diagrams. In the tests with coal B (Fig. 4) the cinder loss is comparatively heavy and the boiler efficiency diminishes in a marked degree under high rates of power, while tests under similar conditions with coal A (Fig. 2), involving less loss by cinders, show an efficiency of the boiler under high rates of power which is much better sustained.

The cinder loss expressed as a percentage of the total weight of coal fired is shown by Figure 5, and the heating value of the material thus accounted for by Figure 6. It will be seen that cinders from coal B have more than double the weight and that each pound has nearly double the heating value of those from coal A, a result doubtless due in part to the large percentage of fine material in coal B and to the absence of such material in coal A. The stack cinders from both coals have a higher calorific value than those caught in the smoke box. Under the practice of the laboratory, the coal was not wetted previous to being fired. Concerning the general significance of the cinder loss as recorded here, it should be remembered that the fuel used in all the tests was of high quality. Lighter and more friable coals are as a rule more prolific producers of stack and front-end cinders.

Radiation, leakage, and all losses not previously accounted for are represented by the distance on ordinates between line H and the 100 per cent. line of the diagrams. Radiation losses are probably not much in excess of 1 per cent., so that the remainder of this loss—from 3 to 8 per cent. of the total heat available

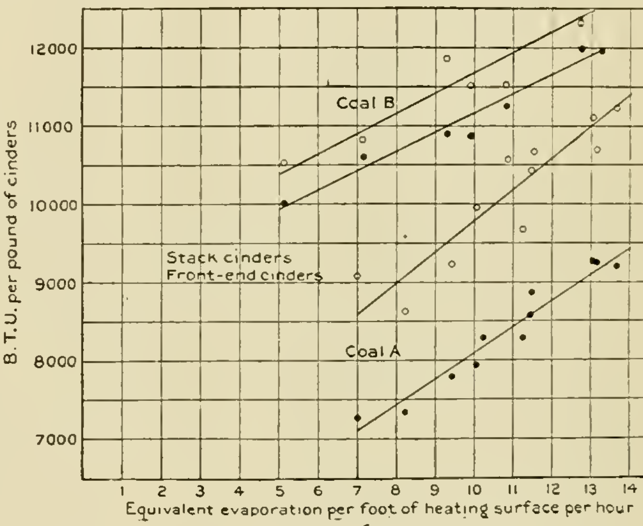


FIG. 6.

—represents leakage of steam or water, or inaccuracy in determining the value of one or more of the quantities already discussed.

Distribution of Heat in the Test Locomotive.

It is sometimes convenient to have an elaborate statement of fact summarized into a few representative figures, the relation between which may be easily apprehended. Such a summary may be framed for the present case by assuming that the normal maximum power of the locomotive tested is that which involves a rate of evaporation of 12 pounds of water per square foot of heating surface per hour, and by averaging from the diagrams (Figs. 2 and 3) the values of the various factors entering into the heat balance for this rate of power. The result may be accepted as showing in general terms the action of such a locomotive as that tested when fired with a good Pennsylvania or West Virginia coal. It is as follows:

Averaged Heat Balance for Test Locomotive.
[Percentages of total heat available.]

Absorbed by the water in the boiler	52	
Absorbed by steam in the superheater	5	
Absorbed by steam in the boiler and superheater		57
Lost in vaporizing moisture in the coal		5
Lost through the discharge of CO		1
Lost through the high temperature of escaping gases, the products of combustion		14
Lost through unconsumed fuel in the form of front-end cinders		3
Lost through unconsumed fuel in the form of cinders or sparks passed out of the stack		9
Lost through unconsumed fuel in the ash		4
Lost through radiation, leakage of steam and water, etc		7
		100

General Conclusions.

There were in 1906, on the railroads of the United States, 51,000 locomotives. It is estimated that these locomotives consumed during the year not less than 90,000,000 tons of fuel, which is more than one-fifth of all the coal, anthracite and bituminous, mined in the country during the same period. The coal thus used cost the railroads $170,500,000. That wastes occur in the use of fuel in locomotive service is a matter which is well understood by all who have given serious attention to the subject, and the tests whose results are here presented show some of the channels through which these wastes occur. These results are perhaps more favorable to economy than those attained by the average locomotive of the country, as the coal used in the tests was of superior quality, the type of locomotive employed was better than the average, and the standards observed in the maintenance of the locomotive were more exacting. But the effect on boiler performance arising from these differences is not great and, so far as they apply, the results may be accepted as fairly representative of the general locomotive practice of the country. They apply, however, only when the locomotive is running under constant conditions of operation. They do not include the incidental expenditures of fuel which are involved in the starting of fires, in the switching of engines, and in the maintenance of steam pressure while the locomotive is standing, nor do they include a measure of the heat losses occasioned by the discharge of steam through the safety valve. Observations on several representative railroads have indicated that not less than 20 per cent of the total fuel supplied to locomotives performs no function in moving trains forward. It disappears in the incidental ways just mentioned or remains in the fire box at the end of the run. The fuel consumption accounted for by the heat balance above is, therefore, but 80 per cent. of the total consumed by the average locomotive in service. Applied on this basis to the total consumption of coal for the country, the heat balance may be converted into terms of tons of coal as follows:

Summary of Results Obtained from Fuel Burned in Locomotives.

	Tons.
1. Consumed in starting fires, in moving the locomotive to its train, in backing trains into or out of sidings, in making good safety-valve and leakage losses, and in keeping the locomotive hot while standing (estimated)	18,000,000
2. Utilized, that is, represented by heat transmitted to water to he vaporized	41,040,000
3. Required to evaporate moisture contained by the coal	3,600,000
4. Lost through incomplete combustion of gases	720,000
5. Lost through heat of gases discharged from stack	10,080,000
6. Lost through cinders and sparks	8,640,000
7. Lost through unconsumed fuel in the ash	2,880,000
8. Lost through radiation, leakage of steam and water, etc	5,040,000
	90,000,000

These amounts, together with the corresponding money value, are set forth graphically by Figure 7. It is apparent from this exhibit that the utilization of fuel in locomotive service is a problem of large proportions, and that if even a small saving could be made by all or a large proportion of the locomotives of the country it would constitute an important factor in the conservation of the nation's fuel supply. On examining the diagram with reference to such a possibility the following facts are to be noted: The amount of fuel consumed in preparing locomotives for their trains, etc. (item 1), is dependent only to a very slight extent on the characteristics of the locomotive, being in large measure controlled by operating conditions, by the length of divisions, and by the promptness with which trains are moved. Under ideal conditions of operation much of the fuel thus used could be saved, and it is reasonable to expect that the normal process of evolution in railroad practice will tend gradually to bring about some reduction in the consumption thus accounted for.

The fuel required to evaporate moisture in the fuel (item 3) and that which is lost through incomplete combustion (item 4) are already small and are not likely to be materially reduced.

The loss represented by the heat of gases discharged from the stack (item 5) offers an attractive field to those who would improve the efficiency of the locomotive boiler. So long as the temperature of the discharged gases is as high as 800° F. or more there is a possibility of utilizing some of this heat by the application of smoke-box superheaters, reheaters, or feed-water heaters, though thus far the development of acceptable devices for the accomplishment of this end has made little progress.

The fuel loss in the form of cinders collecting in the front end and passing out of the stack (item 6) is very large and may readily be reduced. The results here recorded were obtained with a boiler having a narrow fire box; the losses in the form of cinders would probably be smaller with a wide fire box. A sure road to improvement in this direction lies in the direction of increased grate area. Opportunities for incidental savings are to be found in improved flame ways such as are to be procured by the application of brick arches or other devices. Such losses may also be reduced by greater care in the selection of fuel and in the preparation of the fuel for the service in which it is used. It is not unreasonable to expect that the entire loss covered by this item will in time be overcome.

The fuel which is lost by dropping through grates and mingling with the ash (item 7) is a factor that depends on the grate design, on the characteristics of the fuel, but chiefly on the degree of care exercised in managing the fire. More skilful firing would save much of the fuel thus accounted for.

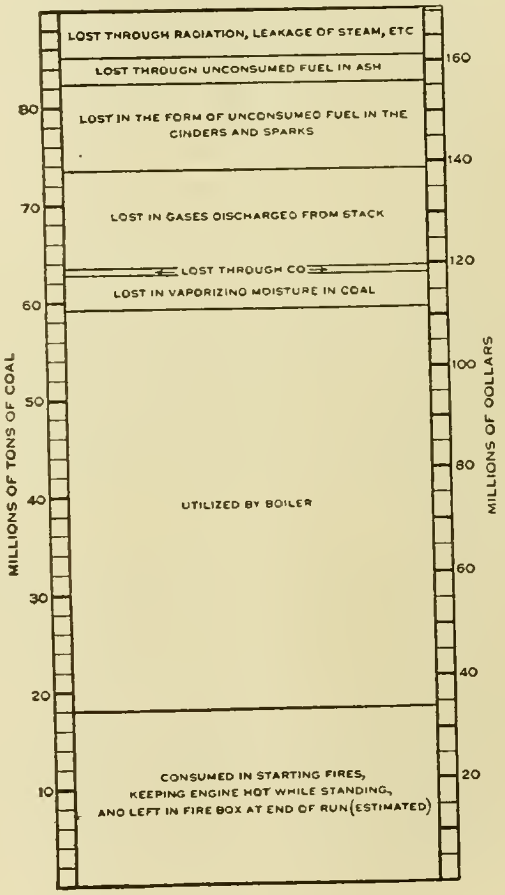


FIG. 7.

The radiation and leakage losses (item 8) may in part be apparent rather than real, owing to possible inaccuracies in the process of developing the heat balance. On the assumption that the values are correct as stated, however, it is not likely that under ordinary conditions of service they can be materially reduced.

Locomotive boilers are handicapped by the requirement that the boiler itself and all its appurtenances must come within rigidly defined limits of space, and by the fact that they are forced to work at very high rates of power. Notwithstanding this handicap, it is apparent that the zone of practicable improvement which lies between present-day results and those which may reasonably be regarded as obtainable is not so wide as to make future progress rapid or easy. Material improvement is less likely to come in large measures as the result of revolutionary changes than as a series of relatively small savings in the several items to which attention has been called.

SOUTHERN PACIFIC ARTICULATED OIL BURNING LOCOMOTIVE WITH CAB AT FRONT END.

ARTICULATED OIL BURNING LOCOMOTIVES WITH CAB AHEAD.

SOUTHERN PACIFIC COMPANY.

It has been suggested a number of times that with oil burning locomotives it would be possible to reverse the customary direction of running and by placing the tender at the other end of the locomotive the engineer could be located where he would have a perfect view ahead without separation from the fireman and leaving him in a position where he could watch the condition of the fire, height of water level, etc. This idea has been put into practice on some of the Italian railways, and, as is

FRONT VIEW OF SOUTHERN PACIFIC ARTICULATED LOCOMOTIVE.

shown in the illustration, is now being inaugurated on sections of the Southern Pacific.

Service with the very large Mallet articulated locomotives, two of which were built by the Baldwin Locomotive Works for this company early in the year, and were fully described and illustrated on page 181 of the May and 367 of the September issues of this journal, soon proved them to be remarkably successful, and this trial order was immediately followed by an order to the same works to build nineteen more of a duplicate pattern. These twenty-one locomotives are distributed on the various Associated Lines as follows: Three to the Union Pacific Railway, arranged for burning coal; three oil burners to the Oregon Railroad and Navigation Company, and fifteen oil burners for the Southern Pacific Company. The last order for oil burners were specified to be arranged with the cab ahead, which decision in this case was largely influenced by the necessity of operating locomotives through tunnels and snow sheds where the gases from the stack were very disagreeable to the crew. This is especially troublesome on these long locomotives where the smoke strikes the top of the tunnel and has time to descend in front of the cab.

In the new design, the cab is entered through side doorways reached by suitable ladders. The cab fittings are conveniently located within easy reach of the engineer, who occupies the right hand side looking ahead. The Ragonnet power reversing gear is the same as on former locomotives, and it is only necessary to run a shaft across the boiler back head in order to make the connection with the operating lever.

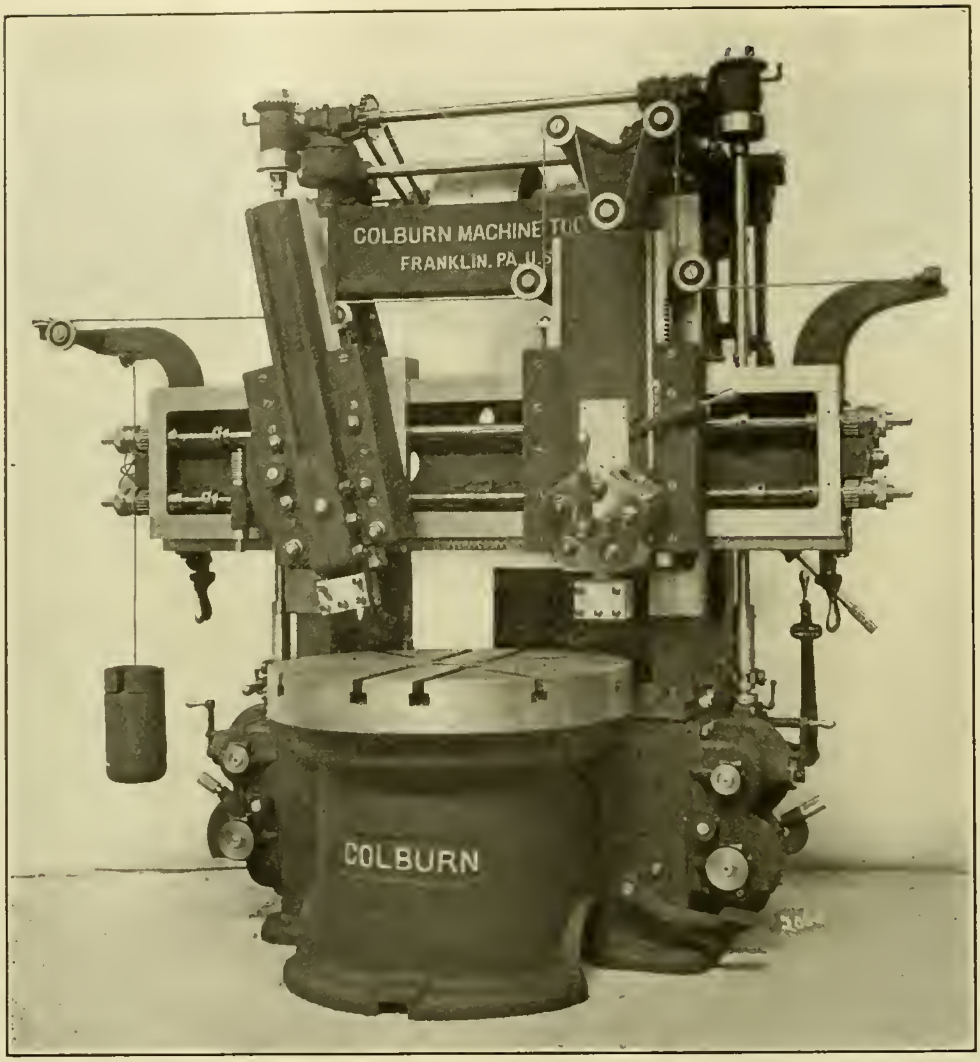
Some slight changes, of course, have been necessary for arranging the bumper beam and pilot at the opposite end of the frames, and of the deck plate at the smoke box end, both of which are of cast steel. The deck plate is provided with a chafing block and a suitable pocket for the tender drawbar and the bumper beam has been located well forward to protect the engine crew from buffing and collision shocks. The tender is of the Associated Lines standard, with a rectangular tank as equipped for oil burning locomotives.

These alterations have made slight changes in the weights, which are as follows:

Weight on drivers	394,150 lbs.
Weight on front truck	14,500 lbs.
Weight on rear truck	17,250 lbs.
Weight, total engine	425,900 lbs.

EDUCATIONAL WASTE.—Of thirteen millions of young men in the United States between the ages of 21 and 35, only five per cent. receive in the schools any direct preparation for their vocations; and of every one hundred graduates of our elementary schools, only eight obtain their livelihood by means of the professions and commercial pursuits, while the remaining ninety-two support themselves and their families by their hands. If we are open to conviction, we need no investigation to convince us that the public school system of this country has not been developed and maintained for the benefit of the masses, but rather has been operating for the benefit of the few. We have no possible right to build up a general scheme of public primary and secondary education with the college as the goal. This is sacrificing the many for the benefit of the few; a useless sacrifice because the few can be taken care of without resorting to such wasteful methods.—*Dr. Alexander C. Humphreys before the National Society for the Promotion of Industrial Education.*

PENSION REGULATIONS ON THE "NORTHWESTERN."—The directors of the Chicago & Northwestern have amended the pension regulations of the company so that hereafter the smallest pension will be $12 a month. This will increase the pensions of about 125 of those now on the list. At one per cent. for each year of service twelve dollars would be the pension for an employee who had worked at $36 a month and had been in the service 33 years, 4 months. By the new regulation such a man will receive the $12 even when his term of service has been much shorter.



"NEW MODEL" 42-INCH BORING AND TURNING MILL WITH TURRET HEAD.

BORING AND TURNING MILLS.

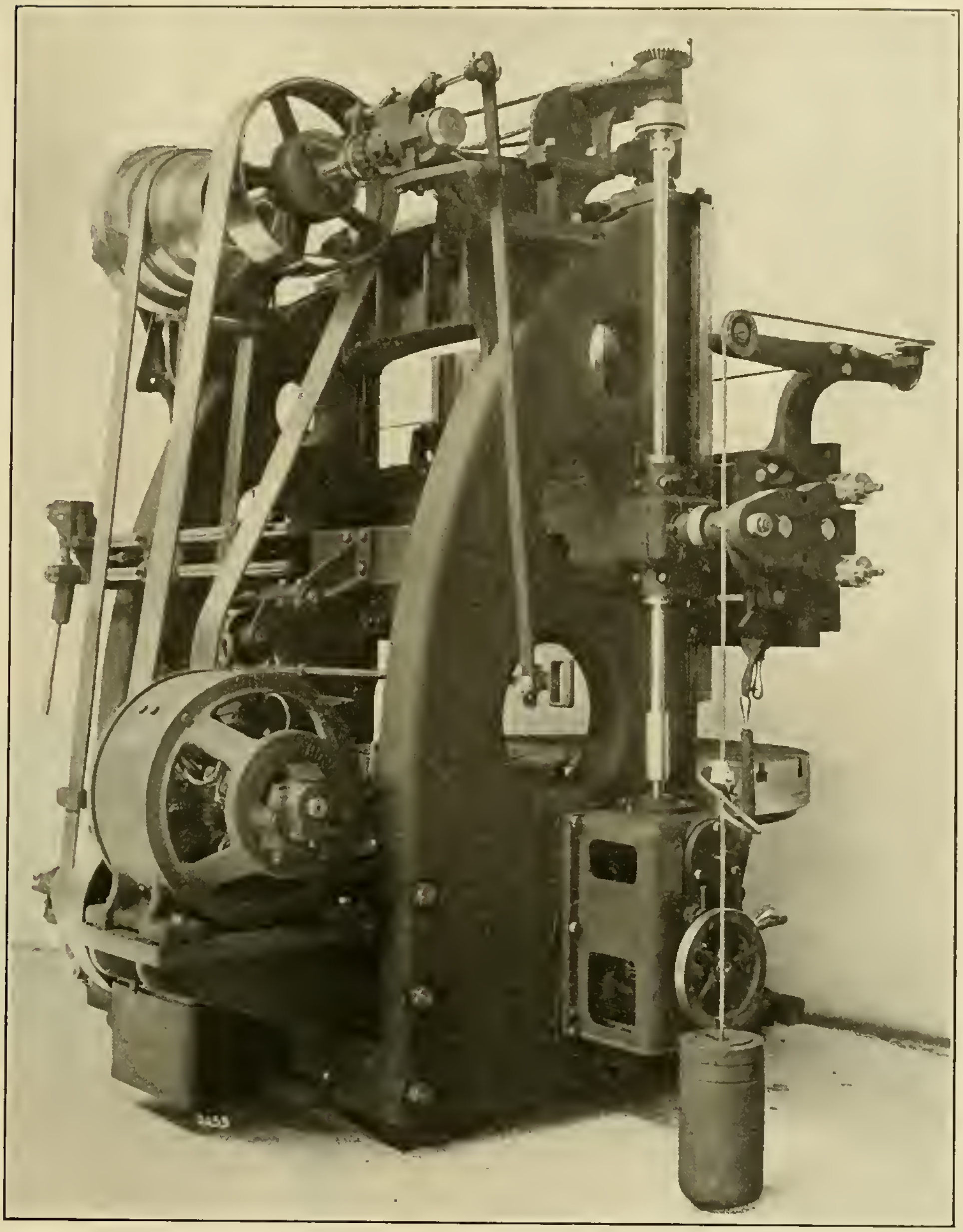
A new line of vertical boring and turning mills, including five sizes—42, 48, 54, 60, and 72 inch swing—has just been brought out by the Colburn Machine Tool Company, of Franklin, Pa. With the exception of the method of driving the table, the same features are incorporated in all the sizes and a description of any one size practically covers all the others. All sizes are built with two swivel heads, and the three smallest sizes with turret heads as desired.

The table spindle has a massive angular thrust bearing which makes it self-centering, and, together with the large straight upright bearings, effectually resists vertical, angular and horizontal strains. All bearing surfaces of the spindle are lubricated from a one-sight feed oil cup. The proper height of the oil is always shown by a mark on the glass. A constant flow of oil is maintained on the large conical bearing. The table is driven by a spur gear of large diameter attached directly to it. No lifting tendency is possible with this type of drive. An external spur gear is used on the 42, 48 and 54 inch mills, and an internal gear on the 60 and 72 inch.

Power is transmitted through the five-step cone pulleys of large dimensions, thence through the speed box containing the back gears and positive clutches which are constantly immersed in a bath of oil. The back gears are engaged and disengaged by means of positive clutches inside of the speed box and operated by a lever conveniently located at the side of the machine. Five speeds are obtained with the back gears out, and five more with the back gears in, making ten speeds in all in geometrical progression. The speed box when assembled is perfectly oil tight and the proper height of oil is shown by the sight feed oil cup on the outside. All the bearings have phosphor bronze bushings, and ring oilers for additional protection against heating. Should it be necessary at any time to make repairs, the speed box may be quickly removed from the machine and every part is then easily accessible.

A belt shifter is furnished on these mills, which is simple, effective and easily operated. By means of this shifter, operated entirely with one hand, the belt may be changed from one step of the cone pulley to another with wonderful rapidity and without injury to the belt. In actual operation the entire range of speeds obtained with the cone pulleys, from the slowest to the fastest and back again, stopping momentarily on each step, has been made in eight seconds. By changing the back gear lever, which is in close proximity to the handle that operates the belt shifter, another run of five additional speeds may be obtained. A speed index plate located on the housing directly above the back gear lever indicates the right step on the cone pulley and the position of the clutches inside of the speed box for any given speed of the table.

The countershaft is attached directly to the upper part of the housings by means of brackets having ring oiling bearings, and thus becomes a part of the machine itself. The belt from the line shaft can be shifted, thus starting or stopping the machine from either side of the mill by means of the horizontal rod having a spade handle at each end. To enable the operator to stop the machine with the table in any desired position, a friction brake is furnished which is operated by a foot treadle placed within easy reach at the operating side of the machine. The brake is applied to the inside of the lower driving cone pulley by means of a taper friction with hard maple shoes or wedges. In actual operation the mill can be stopped and started, all the table



REAR VIEW OF "NEW MODEL" MOTOR DRIVEN BORING AND TURNING MILL.

speeds changed, back gears thrown in and out and the foot brake applied without the operator leaving his position at the side of the machine.

The crossrail is of the box type with deep arched back and is of extra large proportions. It is raised and lowered by power. The swivels are of large diameter with broad bearing surfaces, and the metal over the T-slots is extra heavy to withstand the strain of five large clamping bolts. Angular adjustments are made by worm and gear, which also act as a positive locking device, making it impossible for the heads to accidentally fall over sideways when the clamping bolts are released. The rams are massive and have steel racks inset into their sides. Cored openings extend clear to the top so that extra long boring bars may be used.

The feed mechanism for each head is contained in a separate case, one on each side of the mill. By turning the handwheel one revolution five changes of feed are obtained. A movement of the multiplying lever changes the combination of gears, and another revolution of the handwheel gives five more changes, making ten in all. The vertical feed shaft extending upward from each feed case engages with a mechanism on each end of the rail that conveys motion to the horizontal rods and screws in the crossrail, which operate the heads vertically and horizontally. The usual slip gears on the ends of the rods and screws are eliminated, and quick adjusting positive clutches are substituted which enable the operator to instantly change the feed from vertical to horizontal and vice versa. Either feed may be reversed instantly by the feed reverse lever shown at each end of rail.

Rapid traverse of the tools, horizontally, vertically and in angular directions is obtained from the same vertical shafts as the feed, the manipulation being by a vertical lever attached to the front of the feed case. This lever has two operating positions: Forward and backward. The gear feed is always engaged when the lever is in the back position and the tool will feed in the direction determined by the position of the feed reverse lever at the end of the crossrail. The rapid traverse is always engaged when the lever is in the forward position, and the tool will travel rapidly in the opposite direction from the gear feed. It is impossible for the operator to throw the rapid traverse in the wrong way, and there is no chance for an accident to occur.

It makes no difference whether the tool is feeding to the right or left, horizontally, or up or down vertically, the same lever controls the feed and rapid traverse in every case, and pulling the lever always throws the gear feed out and the rapid traverse in, thus reversing the direction of the travel of the tool. This arrangement of gear feed and rapid traverse simplifies the whole process of rapid manipulation of the tools, and makes a safety device that is not only theoretically but is practically fool proof.

Although the rapid traverse is an indispensable feature, enabling the operator to quickly move the tools in any direction, it does not allow a fine adjustment to be made. To accomplish this it has usually been necessary to go to the end of the crossrail and make the final adjustment by means of a crank handle. This is unnecessary on the "New Model" mills. Both feed screws and rods in the crossrail are splined and each has a capstan collar fitted thereto with keys which fit the spline so that by turning the capstan collars with a small lever furnished for this purpose, the rods and screws are turned also. With this device the operator can stand close to his work and by placing the capstan collars in the most convenient place, make the finest adjustments of the tools in any direction without leaving his position. When the heads are moved out on the end of the crossrail these collars slide back behind the heads, and it is not necessary to make the rails longer on account of them.

A safety shear pin device placed on the rear of each end of the crossrail prevents injury to the feed mechanism in case the heads are accidentally run together or from other causes. Any abnormal strain on the feeding mechanism in excess of that necessary to take the heaviest cuts will shear this pin off and thus protect the gears and mechanism from breakage. The whole operation of taking out the old pin and putting in a new one only takes a few seconds. There is nothing to adjust or to get out of order about the device.

When cutting threads the feed change handwheel is set so that the vertical feed shaft and the table revolve in unison. A single tooth clutch on the lower end of this shaft insures the threading tool always catching the thread in taking successive cuts, and the rapid traverse device is used to return the tool quickly to its starting point.

The thread cutting attachment is not furnished regularly, but can be put on at any time.

A constant speed motor is recommended for these mills, since the mechanical belt shifter and clutches in the speed box give all the changes of speeds desired. The motor is mounted on a bracket at the rear and belted to the pulley on the countershaft. In order to enable the operator to stop and start the mill without stopping the motor a clutch pulley replaces the regular tight and loose pulleys, and is operated by the same levers with handles on both sides of the mill.

TUNGSTEN LAMPS IN A WRECK.

The collision between a Pennsylvania eastbound passenger train and an engine, just outside Jersey City on the morning of November 8th, resulted in comparatively few injuries to the passengers, due to the fact that the strong frames of the passenger cars resisted crushing. One of the steel passenger coaches jumped the track and turned over on its side, denting in the steel plates about 18 inches.

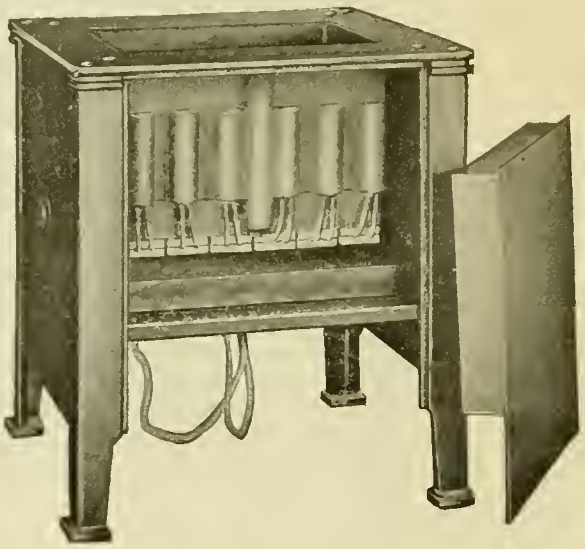
In the lighting equipment of this car were nine General Electric tungsten lamps. After the wreck, when all the lamps were taken out and tested, the tungstens were found to be in perfect condition—a further proof of the rather remarkable strength and durability of the tungsten filament when specially adapted for train lighting service.

Pennsylvania Stockholders.—The average holding of Pennsylvania Railroad stockholders is 115 shares, the par value of which is $5,750. Of the total 55,270 stockholders, 26,904, or 48.62 per cent., are women. There are 16,812 stockholders living in Pennsylvania, the average individual holdings amounting to $4,800 stock. In New York there are 8,648 stockholders, and their average holdings are $11,800 stock. More than 12,000 holders live in New England, while 8,530 are scattered throughout the country. About 18 per cent. of the entire capital stock of the company is held abroad. On November 5 there were 8,726 stockholders in foreign countries, and their average holdings were $6,550 stock. The total number of stockholders of the Pennsylvania has increased by 9,841, or 21.6 per cent., in the past two years.

ELECTRICALLY HEATED OIL TEMPERING BATHS.*

H. Fulwider.

There are several ways of drawing temper, but it is usually accomplished by one of the two following methods: In one, a skilled workman judges the proper tempering temperature by degrees or shades of color; in the other, a thermometer of precision registers the temperature and the workman simply follows a chart—a physiological process against a physical one. In the former method, the steel is introduced into a furnace having a temperature between 500 degrees and 600 degrees F.; in the latter it is immersed in a liquid bath, the temperature of which is between 400 degrees and 550 degrees F. In the first case, good quality of product requires that the workman be experienced, and capable of accurately judging the degree of temper in the metal by the color shown. This means that the operator must be well paid, resulting in a consequent increase in cost of production. With the latter method, it is only necessary to have a table of temperatures corresponding to certain degrees of hardness in the steel. The operator can then place the work in the bath, bring the latter to the required temperature, indicated by a thermometer, and hold it at that temperature as long as necessary. By this last method tools will be produced having a uniform degree of hardness, independent of what workman does the work. In addition to this, one man can temper a greater quantity of tools in a given time than with the air blast furnace of the first method.



ELECTRICALLY HEATED OIL TEMPERING BATH, SHOWING HEATING UNITS.

Formerly the oil tempering bath was heated either by means of gas or fuel oil. These sources of heat, although satisfactory to a certain extent, are objectionable because of the fire risk resulting from an open flame, and the difficulties of obtaining close temperature regulation. Realizing these facts, the General Electric Company has developed a line of electrically heated oil tempering baths which overcome these objections. These baths can be located at any desired point in the factory with perfect safety. The temperature of the bath is easily controlled by means of regulating switches which vary the amount of energy consumed.

The general appearance of the electrically heated bath is shown in the illustration. The bath proper consists of a rectangular cast iron tank having six lugs cast vertically on each side, and evenly spaced; these lugs being drilled out so that "cartridge" type heating units can be inserted in them. It is found that by thus distributing the units, an even temperature can be maintained in all parts of the oil.

* From the November, 1909, number of the *General Electric Review.*

The bath is surrounded by a heat retaining jacket made up of one bottom and four side sections. These sections are built up in the form of sheet metal boxes with an internal space of three inches, which is filled in with mineral wool. The jacketing on both sides of the tank where the units are located is easily removable. This construction allows of quick access to the internal connections of the units.

A wide flange is provided at the top of the tank, and to this are secured four cast iron legs of suitable length. A drain pipe controlled by a globe valve provides a means of drawing off the oil. At one end of the tank there is a protected recess, in which is placed the thermometer that indicates the temperaure of the oil. It is through the agency of this thermometer that the proper degree of hardness can be given to the tools which are being tempered, independent of the judgment or skill of the operator.

When desired, a cast iron basket or tray can be supplied, in which are placed the tools to be tempered. The bottom of the basket is perforated with seven-eighth inch holes which permit the oil to circulate and drain freely. There are feet on the bottom of the basket which keep the work at a distance of one inch or more above the bottom of the bath.

The following table gives inside dimensions, weight, oil capacity and energy consumption of the three standard sizes.

No.	Length	Width	Depth	Weight	Oil	Kilowatt
1	22″	12″	8″	420 lbs.	9 gal.	6
2	18″	12″	12″	475 lbs.	11 gal.	7.2
3	30″	16″	18″	900 lbs.	37 gal.	20

NOTE.—All sizes furnished for either single or multiple heat control.

The maximum energy consumption of these baths is sufficient to heat the oil to a temperature of 450 degrees F., in less than one hour, starting cold. The maximum temperature which it is possible to obtain is about 600 degrees F.; which is very close to the flashing point of the oil commonly used for tempering purposes. The following is a list of tools, with the temperatures to which they should be raised in drawing the temper:

430 Degrees F.	
Scrapers for brass.	Ivory cutting tools.
Steel engraving tools.	Planer tools for iron.
Slight turning tools.	Paper cutters.
Hammer faces.	Wood engraving tools.
Planer tools for steel.	Bone cutting tools.
460 Degrees F.	
Milling cutters.	Chasers.
Wire drawing dies.	Punches and dies.
Boring cutters.	Penknives.
Leather cutting dies.	Reamers.
Screw cutting dies.	Half round bits.
Inserted saw teeth.	Planing and molding cutters.
Taps.	Stone cutting tools.
Rock drills.	
500 Degrees F.	
Gouges.	Wood boring cutters.
Hand plane irons.	Drifts.
Twist drills.	Coopers' tools.
Flat drills for brass.	Edging cutters.
530 Degrees F.	
Augers.	Cold chisels for steel.
Dental and surgical instruments.	Axes.
550 Degrees F.	
Gimlets.	Cold chisels for wrought iron.
Cold chisels for cast iron.	Molding and planing cutters to be filled.
Saws for bone and ivory.	Circular saws for metal.
Needles.	Screwdrivers.
Firmer chisels.	Springs.
Hack saws.	Saws for wood.
Framing chisels.	

In shop practice there seems to be a difference of opinion in the matter of drawing the temper of tool steel, the point of contention being whether the steel should be gradually raised to the tempering point, or whether it should be plunged into a bath which is already at the tempering temperature.

The difference gives rise to two methods of oil tempering. The first is to bring the bath to a temperature of about 250 degrees F., then place the work in the bath, and turn on full heat until the oil reaches the desired temperature, when the current is turned off and the work removed. If this procedure is followed, the steel, being introduced at a comparatively low temperature and then gradually heated to the proper point, is not subjected to any shock, and there is therefore no danger of injuring the quality of the tools.

The second method is to maintain the oil bath at the required temperature and plunge the steel into the oil, allowing it to remain there just long enough to acquire the same temperature evenly throughout the metal. The tools are then removed and a new lot is submerged.

By this latter method the process of tempering can be carried on without interruption, whereas in the first method it is necessary each time to cool the bath down to a temperature of about 250 degrees F. before introducing a new lot of steel, with a consequent decrease in output. Thus both methods have their advantages; but the one of gradual heating up involves no doubt as to the quality of the tool.

TECHNICAL PUBLICITY ASSOCIATION.

The Technical Publicity Association held its December meeting on Thursday, the 9th. After the usual informal dinner a lively discussion ensued over the subject of circulation and the introduction of the proposed uniform advertising contract for trade papers. The attendance was large, and the participation in the discussion of prominent technical advertising men and trade paper publishers, who were present, made the session a most profitable one.

William H. Taylor, treasurer and manager of the *Iron Age*, opened the discussion, giving it as his opinion that the true measure of a publication is its editorial quality. He said there was no more discriminating class of people in existence than subscribers to a publication. Advertisers should put themselves in the proper frame of mind in approaching the circulation question. He granted their perfect right to know how many and who read a publication, and he said no good publication refuses such information. The trouble has been, not that the publishers have been ashamed of their circulation, but that wrong deductions may be made when a reputable publisher's statement is placed in comparison with an untruthful one.

H. L. Aldrich, publisher of *International Marine Engineering* and the *Boiler Maker*, exampled his papers as an instance of necessarily small circulation with intensified buying power in which quality was by far the greater consideration.

C. S. Redfield, advertising manager of the Yale & Towne Mfg. Co., and president of the T. P. A., explained how members considered the circulation statements of publishers, being in some cases absolute sworn statements, also the possibility of detecting the liars.

John McGhie, of the *American Machinist*, told about the passing of old-time advertising solicitation in which the hypnotic eye played a prominent part, and said that after trying all other policies, publishers have learned that the truthful policy is the best. The advertiser buys reputation and editorial force quite as much as circulation.

O. C. Harn, advertising manager of the National Lead Company, said that every good advertising man was perfectly aware of the value of quality in circulation, but said that, nevertheless, it came down to quantity after all, but based on judgment of that quantity from a quality standpoint.

H. H. Sweatland, publisher of *Automobile*, said it was his purpose as a publisher to furnish maximum quantity, but that for a class paper to go beyond a certain quantity was simply to vitiate itself. A phenomenal solicitor, he said, once got a thousand subscriptions within a radius of twenty miles, but after two years only one more subscriber was on the list for that district than there was prior to his solicitation.

A HEAVY FREIGHT TRAIN.—A trainload of coal drawn over the Virginian Railway recently, consisting of 120 steel coal cars, with an engine and caboose, is said to have been 5,286 ft. long, or 6 ft. more than a mile. The weight of the coal in the train is given as about 6,000 tons.

GOOD RESULTS FROM THE USE OF A GRAPHIC RECORDING METER.

An example of the value of the graphic recording meter * for analyzing power loads was recently shown in a sub-station that supplies power to the terminal yards of a large railroad system. In this instance, as a result of the application of the meter, it was found possible to reduce the capacity of the machines operating by more than half, thereby diminishing operating expenses and improving the efficiency and load factor of the remaining generating equipment.

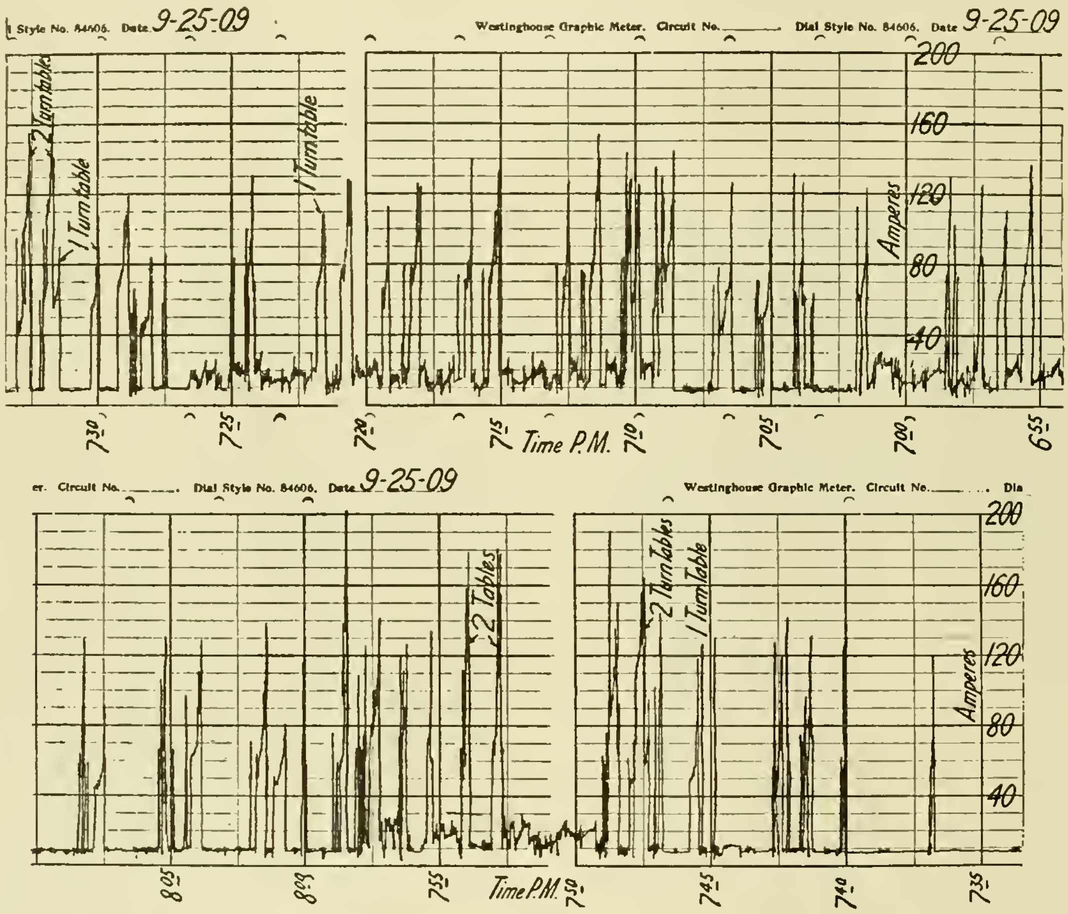
The sub-station referred to contains one 37½ k.w. and two 25 k.w. motor generator sets. These supply direct current at 250 volts to three turntables and one small crane. Each of the turntables is driven by a 22 h.p. series motor with rheostat controller, and is capable of turning a locomotive 180 degrees, or end for end, in one minute. The crane is about five tons capacity and subject to very intermittent service, so that its operation has little effect on the total station load.

The turntables are held ready for service at all times. Rush hour periods occur in the morning and evening, and at these times the tables are usually very busy. A locomotive to be turned goes to the nearest unoccupied table, and in this way it is rarely the case that two turntables are started at once, although two or three may be in operation at the same time.

Before the study of the actual load conditions had been begun, it was customary to operate all three motor generator sets during the rush hours. At these times the violent oscillation of the needles of the indicating meters on the generating panels, striking against the stops, seemed to indicate that more generating capacity was needed. In order to determine this latter question definitely, a Westinghouse graphic recording meter was obtained and inserted in the main feeder. The tests covered a week's careful study, during which time the load on the station was continuously recorded. That section of the curve reproduced herewith was secured during one of the rush periods. To obtain a clear record, a paper speed of 24 inches per hour was used.

The record shows that the average peak encountered during the starting of a turntable is 120 amperes. This drops to a value of from 50 to 70 amperes during operation, after the table has been accelerated. The maximum peak noted was about 180 amperes at the time of starting two turntables simultaneously. As the full load current of the 37½ k.w. motor generator set alone is 150 amperes, it becomes very clear that the existing station capacity is ample to handle the present service besides a large future increase.

Since the tests it has been found necessary to operate only the one largest unit, and the former practice of running all three sets has accordingly been discontinued. The result has been improved operating economy, efficiency and load factor. In spite of a suspected insufficient station capacity, it was demonstrated that less than half the equipment already installed was needed for the existing demand.



GRAPHIC RECORDING METER RECORD OF POWER REQUIRED FOR OPERATING THREE TURNTABLES AND A SMALL CRANE.

* Described in the August, 1909, issue of this journal, page 323.

THE AIR BRAKE MAGAZINE.

The first number of a new monthly magazine, known as *The Air Brake Magazine*, published at Meadville, Pa., was issued about the first of December. It is 7 by 10 inches in size and has 66 pages of editorial matter, including several illustrated articles. The editorial department is under the management of Frank H. Dukesmith, well known as an air brake expert and as the author of "Modern Air Brake Practice, Its Use and Abuse." He will have as associate editors W. H. Foster, a master mechanic of the New York Central Railroad, and formerly general air brake supervisor of that system; J. C. Hassett, technical instructor of apprentices of the Erie Railroad; T. W. Dow, general air brake supervisor of the Erie Railroad; and H. F. Mentzel, S. M. P. of the Allegheny Valley Street Ry. Co.

A VANADIUM BRONZE FOR RAILROAD SERVICE.

Vanadium, the master alloy, has enabled the manufacturer and the foundryman, by reason of its incorporation in iron and steel, to produce locomotive frames, cylinders, springs, tires and wheels with double the strength, elasticity and wearing qualities heretofore attained. The same distinctive advantages are found in a composition called Victor vanadium bronze, which is a secret alloy containing vanadium, embracing qualities of strength, lightness and forging powers said to be possessed by no other brass or bronze on the market.

The most important properties claimed for it are: It is a very clean and uniform metal, with the strength of high priced alloy steels, as demonstrated by the tables herewith presented. It has a very close structure and wonderful ductility, as evidenced by the illustration showing the twisted lever. Its wearing qualities are 50% superior to the bearing metals in general use on the railroads. It is lighter in actual weight than any other bronze casting of the same dimensions. It is the only bronze that can be forged satisfactorily.

Vanadium is unexcelled as a cleanser and scavenger. It removes all the poisonous gases and impurities and has the peculiar property of practically eliminating the danger of crystallization. Uniformity of metal is assured and a closeness of structure is attained that not only toughens the molecular structure, but also eliminates the porous features so often encountered in brass and bronze.

The wearing qualities of this metal are shown in a comparative test with a regular bearing metal that is practically the same as that used by the majority of railroads for locomotive bearings, and also with a high grade bearing metal. Great weight is always an undesirable feature and is the first thing sacrificed if the strength is not impaired. Victor vanadium bronze has been practically standardized in the submarine vessels of the United States Navy, where bronze must be used in many places instead of iron or steel, on account of its anti-corrosive properties, not only because of its superior strength and ductility, but also because it is so much lighter in weight than any other bronze casting.

COMPARATIVE BEARING TESTS OF VICTOR VANADIUM BRONZE AND OTHER COMPOSITION METALS.

Bearing Number	R. P. M.	Load In Lbs.	Time Min.	Sec.	
1	400	3000	2	15	Victor vanadium bronze
2	400	2000	1	30	Victor vanadium bronze
3	400	2000	1	45	Victor vanadium bronze
4	400	2000	1	00	Regular bearing metal
5	400	2000	1	15	High grade bearing metal
1	400	3000	2	15	Victor vanadium bronze
2	400	2000	1	30	Victor vanadium bronze
3	400	2000	1	45	Victor vanadium bronze
4	400	2000	1	00	Regular bearing metal
5	400	2000	1	15	High grade bearing metal

Composition No. 1. Type "C" Special Victor vanadium bronze.
" No. 2. Type "B" Superior Victor vanadium bronze.
" No. 3. Type "A" Regular Victor vanadium bronze.
" No. 4. Regular bearing metal—81% copper, 9% tin, 6% lead, 4% spelter, trace of phosphorus.
" No. 5. High grade bearing metal, 84% copper, 12% tin, 4% lead, trace of phosphorus.

Each of the samples of metals were placed on the machine twice. It will be noted that the time of run checked up exactly in each case. The bearings were placed on a shaft 2 15/16 in. diameter, and the bearing surface in each case was 9 square inches. The speed throughout the test was the same, 400 revolutions per minute. 50% more load was applied to special Victor vanadium bronze composition and its time of run was much greater than the other metals. The load applied amounted to 333.33 lbs. per square inch in special Victor vanadium bronze bearing and 222.22 lbs. per square inch in all the other bearings.

Forging bronze castings has been considered a lost art, but this metal will forge very readily, as shown by the twisted lever in the illustration.

TWISTED LEVER SHOWING FORGING POSSIBILITIES OF VANADIUM BRONZE.

One of the most expensive items in railroad repair work is bearing brass, and any feature tending to diminish this expense is of decided interest to every railroad. No parts are subjected to more wear and tear and are more essential to the safety and economy of railroad transportation than the bearings of locomotives and cars. Innumerable compositions have been tried and many patented forms and devices have been tested, until the railroads, with very few exceptions, have adopted the general formula of 80% copper, 10% tin, and 10% lead for bearings. This composition has by no means eliminated hot boxes, melted bearings, or many other troubles too numerous to mention, but has remained in general use for some time for lack of something better.

Victor vanadium bronze, by reason of its ductility and wearing qualities, as shown by the table of tests, its toughness and strength, and its lighter weight, make it an ideal metal for bearings of all descriptions. By its use repair costs and loss incidental to time out of service when in the repair shop, are cut in half and hot box troubles will be reduced to a minimum.

Injectors and valves must use brass or bronze and great difficulty has been experienced in getting a metal that is not only non-corrosive, but with a sufficiently close molecular structure and strength to withstand the pressures. Victor vanadium bronze has been subjected to a pressure of 9,000 pounds in a cylinder only nine-sixteeenths inch thick, three inches in diameter, and fifteen inches long.

This metal has also been used with great success in locomotive bells. The principal requirements for this service is a metal that will give a pure, full ringing sound, which is, however, only obtained with an alloy showing in addition to great homogeneousness and hardness a considerable degree of strength. Tin is used to a great extent to obtain this condition, and while hardness and clearness of tone are attained it reduces the metal to such a state of brittleness that fractures are very likely to occur. As Victor vanadium bronze is a pure, uniform metal of close structure, with a strength equal to that of high priced alloy steels, it makes an ideal metal for bells.

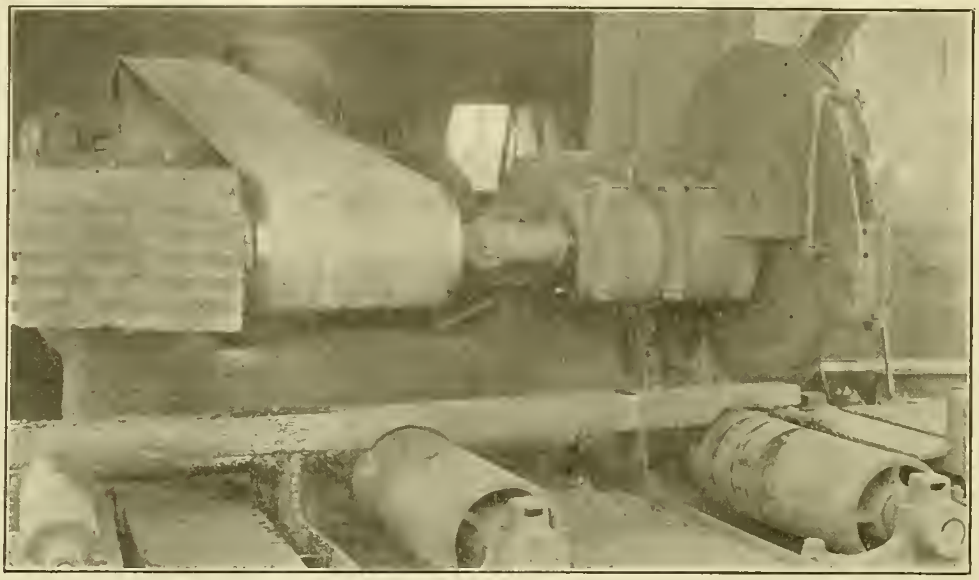
The physical properties shown in the test tables herewith presented prove the economic necessity of such a metal in all movable and frictional parts where corrosion is liable to occur and in bearings, valves, injectors, rods, tubes and other parts liable to unusual shocks, strains, stresses and vibrations.

VICTOR VANADIUM BRONZE.

	Ultimate Strength	Elastic Limit	Elongation 2 inches	Reduction of Area
Plate-Hot Rolled	72,300	34,050	29%	22.8%
Plate-Cold Rolled	95,270	74,510	10%	12.2%
Rod-Hot Rolled, 5/8" to 1/2"	96,000	83,900	7%	12.6%
Rod-Cold Rolled, 3/4" to 5/8"	92,090	80,070	11.5%	29.3%
Wire 3/8"	101,000	83,180	10%	31.8%
Castings	71,000	28,500	32%	27.8%

Victor bronze was formerly owned and manufactured by the Victor Metals Company of Massachusetts, and their business was practically confined to marine work; the Vanadium Metals Company of Pittsburgh, Pa., who have purchased the process, etc., have inaugurated an aggressive campaign for railroad work, and expect to make the latter their special field.

Emery wheels run wet are usually operated at a speed of 4,000 ft. per minute, which is about as fast as they can run and keep the water on the surface of the wheel.



A BELT DRIVING A FRICTION SAW AND OPERATING SUCCESSFULLY IN EXCEPTIONALLY SEVERE SERVICE.

REMARKABLE BELT PERFORMANCE

One of the most interesting examples of belt transmission to be found in this country is at the Passaic Steel Company, Paterson, N. J. Under a barn-like shed at one side of the plant is a great friction saw that has teeth 2½ inches apart; the teeth are no more than slight indentations. This saw runs at such a high speed that it will cut in two a Bessemer steel rail in just eleven seconds. It is also used to cut 20-inch I-beams.

It was a most difficult problem to find a belt that would not only transmit more than 200 horsepower, but which would hold up when going at a rate of more than a mile and a half per minute. The saw is operated by a 250 horsepower motor. The driving pulley of the motor is 44 inches in diameter, and the driven pulley is 14 inches in diameter. To operate the saw at sufficient speed it is necessary for the driven pulley to operate at a rate of 2,800 revolutions per minute. This means that the belt must travel 9,324 feet per minute.

Three months ago a Victor-Balata belt was installed. It was put on at first installation with Jackson fasteners. When operating at this high rate of speed the roar of the Jackson fasteners coming in contact with the air and pounding on the small pulley could be heard for blocks. It was decided to take off the Jackson fastener on this account and the 24-inch, 6-ply belt was fastened by means of a hinged rawhide lace joint. Since that time the belt has been working smoothly and evenly. One of the difficulties in connection with this service is that the belt is required to pull the entire load the instant the saw touches the rail. The driven pulley is entirely out of doors. The freezing and moisture and the fine steel chippings getting on the pulley side of the belt have not affected it.

POSITIONS OPEN IN GOVERNMENT SERVICE.

The United States Civil Service Commission announces an examination on January 12, 1910, to secure eligibles from which to make certification to fill vacancies as they may occur in the position of engineer-physicist at $3,000 per annum or associate engineer-physicist at $2,000 to $2,500 per annum, in the Bureau of Standards. It is desired to secure persons who are fully able to initiate and carry on independent research in the field of engineering physics. They should have training and experience in the inspection and testing of engineering and structural materials, the operation of testing machines, and the interpretation of the results of investigations. There will be no educational examination for these positions, but it is essential that applicants should have made and published some contributions of recognized merit in engineering knowledge. Applicants should submit the titles of all papers they may have published and give references to the original source of publication. Applicants will be rated according to their training, experience, and original investigations. Applicants must furnish on the application form the vouchers of two persons who are able to testify from their personal acquaintance in reference to the fitness of the applicant for the position sought. It is desirable that the vouchers should be persons belonging to the same profession, or pursuing the same line of work as the applicant. Age limit, 25 years or over on the date of examination.

The Commission also announces an examination on January 19, 1910, to secure eligibles from which to make certification to fill two vacancies in the position of engineer in wood preservation, one at $1,000 and the other at $1,300 per annum, Forest Service, for duty in District No. 2, with headquarters at Denver, Colorado, and vacancies requiring similar qualifications as they may occur, unless it shall be decided in the interests of the service to fill either or both of the vacancies by reinstatement, transfer, or promotion.

Applicants for the above positions should apply at once to the United States Civil Service Commission, Washington, D. C.

HIGH PRESSURE PINTSCH GAS FOR TRANSPORT SERVICE.

Recent experimental research made by the Pintsch Compressing Co. has developed the fact that dry Pintsch gas such as is obtained by the regular Pintsch process is suitable for transportation under a pressure of 100 atmospheres or over. For this purpose Pintsch gas, from which all liquid hydrocarbons have been removed while under the pressure of 14 atmospheres, is used, and the dry gas is compressed directly into steel flasks at high pressure. Under this high pressure a partial condensation of the gas takes place, which, however, disappears as soon as the pressure is reduced, the gas presenting again its original dryness and other characteristics with but an inappreciable loss in candle power.

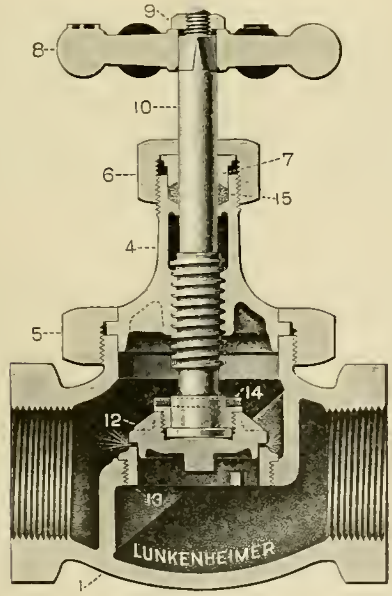
A steel flask of 3.75 cubic feet capacity and weighing about 330 pounds, will, when charged to a pressure of 100 atmospheres, yield about 500 cubic feet of gas at atmospheric pressure. From this it is seen that the gas under these high pressures deviates considerably from Boyle's Law, in accordance with which the flask would be expected to yield but 375 cubic feet of gas at atmospheric pressure. The deviation from Boyle's Law at a pressure of 100 atmospheres amounts to about 33%, the flask containing a correspondingly larger quantity of gas. This departure, combined with the fact that small seamless flasks can be constructed of an extremely high tensile strength steel, render it possible to reduce the weight of the transport holder for a given quantity of gas carried by over 50% of that of the former weight of transport holders used. The space or volume occupied by the high pressure holders is, at the same time, nearly ten times less than that of the holders used in transporting gas at a pressure of 14 atmospheres.

The true value of the high pressure transportation becomes most apparent in cases where no compressing facilities are available at the point of distribution to transfer the gas from the transport holder to buoys or cars; or where, in other words, filling can only be accomplished by equalizing the pressure. In such cases, but about 30% of the gas carried in transport holders at a pressure of 14 atmospheres is available for filling, and the remainder of the gas returns to the supply station unused. In the case of high pressure transportation, however, fully 90% of the gas transported becomes available for filling, and under these circumstances the reduction in weight of the transport holders for a given quantity of gas filled to buoys or cars, is about six times less, and the volume about thirty times less than that of the transport holders used by the former method.

There exists a distinct difference between high pressure Pintsch gas and the so-called Blau gas. The former is a dry gas, possessing all the well-known characteristics of regular Pintsch gas, great care being taken in the process of manufacture to remove from the gas all liquid hydrocarbons. The same liquid hydrocarbons are retained in the Blau gas, and others added, to exert a solving influence upon the remaining dry constituents of the gas, and thus effect a reduction in volume. The presence of the hydrocarbon liquids is the direct cause of difficulties experienced in connection with Blau gas, due to accumulation of liquid in the regulating devices at the point of consumption, and due to freezing up in cold weather.

AN IMPROVED VALVE.

Because of its durability and efficiency, the valve shown in the illustration has been adopted by a number of railroads. It is made of a bronze composition containing a high percentage of copper and tin and will readily withstand long and severe usage. The most important feature in the design is the construction of the seat and the disc. The disc, 12, is provided with a projecting



"RENEWO" VALVE.

ring that enters the valve seat ring, 13. Its principal function is the preservation of the seat, which is accomplished in a twofold manner: First, as it enters the seat, it deflects the current of steam from the seat ring face, thus preventing the wire drawing that would otherwise occur; this feature is especially important should the valve be left partially open for any length of time. Second, the seating surface is kept free from scale and grit by the action of the thin current of steam discharged over it as the disc is brought home.

Another function of this extension ring is the prevention of water-hammer, caused by the sudden admission of steam, for it will readily be seen that no matter how quickly the handwheel may be operated, the flange will only permit the steam to enter gradually.

The seat, 13, is made of nickel and is removable; it may be removed from the valve body by using a flat bar to engage the lugs on the inside of the ring. Attention is directed to the fact that the seat may be reground a number of times before it is necessary to renew it. Not only is the seat renewable, but all of the other wearing parts, including the disc, can be renewed if necessary. The hub is securely held to the body by means of a union ring, making it impossible for the hub and body to become corroded together, as the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body. This connection also acts as a tie or binder in screwing over the body, and tends to strengthen the valve. The stuffing-box can be repacked under pressure when the valve is wide open, as a shoulder on the stem, directly above the threads, forms a seat beneath the stuffing-box.

The valve is guaranteed for working pressures up to 200 pounds, and is made in globe, angle and cross patterns with screw or flange ends. It is used on the Union Pacific Railroad in connection with the ash pan equipment. This type of valve is known by the trade name of Renewo, and is manufactured by the Lunkenheimer Company of Cincinnati, Ohio.

PENSIONS ON THE NEW YORK CENTRAL.

All employees are to be retired at the age of 70, even though they may not have served the necessary term of ten years to entitle them to a pension. If twenty years in service and unfit for duty an employee may be retired with a pension, although he has not reached the age of 70. Employees who wish to be retired before the age of 70, will have to submit to examination by a physician. In computing the length of time that an employee has been in the service, his service on any of the roads owned, leased or operated by the New York Central will be counted, provided, in the case of a transfer from one company to another, the transfer was not because of dismissal or suspension, and was approved by the employing officers of both lines. A temporary lay-off, of not over one year, on account of reduction of force, and suspensions for discipline, will not be treated as causing a break in the continuity of service.

The rates will be similar to those of the Pennsylvania, 1 per cent. of salary for each year of continuous service, based on the average salary for the last 10 years. The Pension Board will consist of J. Carstensen, A. H. Smith, C. D. Schaff and A. H. Harris, vice-presidents; R. H. L'Hommedieu, general manager (Michigan Central); J. F. Deems, general superintendent of motive power; D. C. Moon, general manager (Lake Shore), and J. Q. Van Winkle, general manager (C., C., C. & St. L.). The New York Central has appropriated $225,000 for the first year; the Lake Shore & Michigan Southern, $85,000; the Cleveland, Cincinnati, Chicago & St. Louis, $70,000, and the Michigan Central, $56,000. The usual proviso is inserted in the rules that, if necessary to keep within the limit of the appropriation in any year, the directors may reduce the rate of the pensions.

INDUSTRIAL EFFICIENCY.—The problem of the industrial efficiency of the coming generation is inextricably interwoven with the problems of public playgrounds and gymnasiums, of the sanitation of houses, of the congestion of tenements, and of the hours of labor of women and children.—*Dr. George H. Martin before the Nat. Soc. for the Promotion of Industrial Education.*

ELECTRIC DRILLS AND GRINDERS.

In the June, 1909, issue of this journal the Coates flexible shaft was described in connection with several applications of special interest to the railroads. The use of a flexible shaft of this type, having a high degree of efficiency in transmitting power, has made it possible to use to advantage portable electric motors

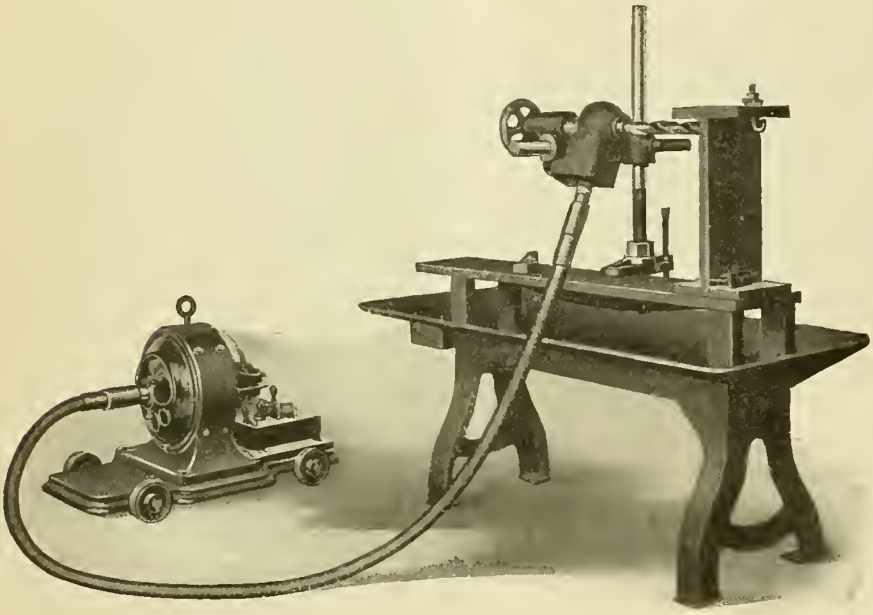


FIG. 3. PORTABLE DRILLING OUTFIT.

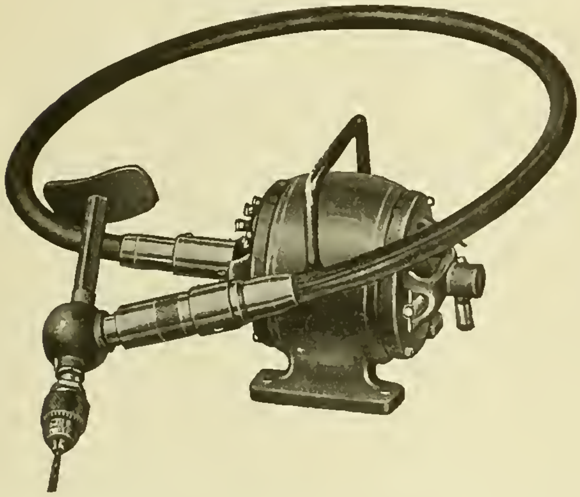


FIG. 1. BREAST DRILL DRIVEN BY AN ELECTRIC MOTOR AND FLEXIBLE SHAFTING.

for drilling and grinding operations throughout erecting shops and engine houses.

Fig. 1 shows a breast drill driven through a 6 ft. No. 31 Coates unit link flexible shaft by a 1/4 h. p. motor. The motor may be placed on the floor out of the way, leaving the free use of both hands for handling the breast drill and the light flexible shaft. The drill may be instantly started or stopped by giving the sleeve a quarter turn. The twist drill may be removed and be replaced by a clamp spindle that takes emery wheels or buffers. The breast drill in the illustration is designed for drilling in steel up to 1/2 in. It has a 6 1/2 to 1 worm feed reduction. The flexible shaft thus operates at six and one-half times the speed of the drill, adding to its efficiency.

The larger size breast drill (Fig. 2), having a variable speed, may be used in place of the one shown in Fig. 1. This drill has three changes of speed, obtained by moving the changing button, and giving speed reductions of 4.8 to 1, 7.5 to 1 and 12 to 1. The chuck has a 1/2 in. capacity but is strong enough to drill a 3/4 in. hole. It is equipped with ball bearing thrusts. The speed variation is obtained by gearing in the drill, the flexible shaft and motor operating at a constant high speed and thus at maximum efficiency at all times.

An application of a drilling outfit including a one horse power

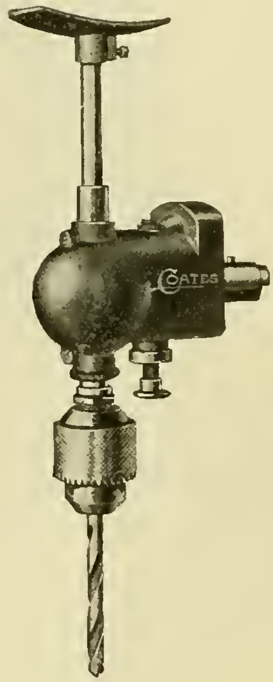


FIG. 2. VARIABLE SPEED BREAST DRILL.

electric motor, mounted on a truck, eight feet of flexible shaft, a variable speed drill and an "old man" and a press holder is illustrated in Fig. 3. This drill has a spindle with a Morse taper, No. 3, and will handle drills up to 1 1/4 in. in diameter. These devices are manufactured by the Coates Clipper Mfg. Co., of Worcester, Mass.

ALL-STEEL BUSINESS CAR.—An all-steel business car has been completed at the Altoona shops of the Pennsylvania Railroad for the exclusive use of the executive officers. No wood whatever was used in the construction of the car. It is to be equipped with the usual conveniences, such as typewriters, telephone, desk, maps and statistics, for carrying on the business of the company.

RAILWAY CLUBS.

Canadian Railway Club (Montreal).—At the next meeting, January 4th, there will be a discussion on the revision of the Master Car Builders' rules and the standards of the Master Mechanics' Association.

The annual dinner will be held at the Windsor Hotel on Friday evening, January 28th.

Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

Central Railway Club (Buffalo).—The annual meeting will be held at the Hotel Iroquois on Thursday, January 13th, at 2 P. M. W. O. Thompson, master car builder of the western division of the N. Y. C. & H. R. R. R., will read a paper on "Car Interchange; Its Past, Present and Future."

The annual dinner, which ladies are privileged to attend, will be held at 7:30 P. M. It will be preceded by a reception in the main parlor of the Hotel Iroquois. The attendance of the Hon. Louis Fuhrmann, Mayor-elect of Buffalo, and a number of prominent railroad officials is probable. There will be a musical program with addresses by Frank Hedley, of New York City, vice-president and general manager of the Interborough Rapid Transit Co., and second vice-president of the New York Railroad Club; Col. B. W. Dunn, of New York City, chief inspector, Bureau of Explosives, American Railway Association; E. Chamberlin, of New York City, chairman freight car repair pool, New York Central Lines; E. F. Knibloe, of Buffalo, general agent of the Buffalo Creek Railroad; E. M. Tewkesbury, general superintendent of the South Buffalo Railway, and second vice-president of the club, will be toastmaster.

Secretary, H. D. Vought, 95 Liberty street, New York City.

Iowa Railway Club (Des Moines, Ia.).—Next meeting, Friday, January 14. Secretary, W. B. Harrison, Union Station, Des Moines, Ia.

New England Railroad Club (Boston).—The January meeting will take the form of a dinner at the Hotel Somerset, Boston, Mass., on January 12. The speakers will be Hon. E. S. Draper, governor of Massachusetts; W. C. Brown, president of the New York Central Lines, and Geo. A. Post, president of the Railway Business Association. The general subject of the evening will be the increasing, in New England, of sentiments looking toward conciliation between the public and the railways. W. B. Leach, treasurer and general manager of the Hunt-Spiller Mfg. Corporation, Boston, a former president of the New England Railroad Club and now an executive member of the Railway Business Association, is chairman of the dinner committee.

Secretary, Geo. H. Frazier, 10 Oliver street, Boston, Mass.

New York Railroad Club.—Next meeting, Friday evening, January 21. Subject not yet announced. Secretary, H. D. Vought, 95 Liberty street, New York City.

Northern Railway Club (Duluth).—The paper on "Pooling Locomotives" by C. J. Whereat, traveling engineer of the Great Northern Railway, which was scheduled for the December meeting, will be presented at the next meeting, January 22nd.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

Railway Club of Pittsburgh.—J. R. Alexander, general road foreman of engines of the Pennsylvania Railroad at Altoona, will present a paper, "Supervision Tending to Economy in the Operation of Locomotives," at the next meeting, January 28th. About 60 new members have been received into the club at the last two meetings.

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

Richmond Railway Club.—At the meeting on January 10th, Geo. H. Whitfield, general superintendent of light and power of the Virginia Passenger & Power Company, will present a paper on "Terminal Freight Handling by Electrical Machinery," prepared by H. McL. Harding under the auspices of the International Lecture Institute. This is a description of what has been accomplished by electricity in the movement of miscellaneous freight, including methods of prominent manufacturers, and the requirements which freight handling machinery must fulfil to be acceptable to railway engineers and to others interested in terminal freight.

At the annual meeting in November the following officers were elected: President, H. M. Boykin, division freight agent, Seaboard Air Line; first vice-president, A. H. Moncure, master car builder, Richmond, Fredericksburg & Potomac R. R.; second vice-president, T. M. Ramsdell, master car builder, Chesapeake & Ohio Ry.; third vice-president, J. H. Witt, superintendent, Seaboard Air Line Ry.; secretary-treasurer, F. O. Robinson, C. & O. Ry.

Southern & Southwestern Railway Club (Atlanta, Ga.).—The next regular meeting will be held January 20, at 10 A. M.

Secretary, A. J. Merrill, 218 Prudential Building, Atlanta, Ga.

St. Louis Railway Club.—J. J. O'Brien, supervisor car department of the Terminal Railroad Association, St. Louis, Mo., will speak on "Freight Car Interchange Inspection" at the next meeting, January 14th.

The annual Christmas entertainment was given in the Odeon Theater on December 10th and was attended by the members and their families to the number of 1,700.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Canada Railway Club (Winnipeg).—"The Stores Department and Its Relations to the Other Departments" will be the subject of the paper for the meeting of January 10th. It will be presented by A. E. Cox, storekeeper of the Canadian Northern Railway.

H. B. Lake, chemist of the Canadian Pacific Railway, read a paper on "Water Service" at the December meeting.

Secretary, W. H. Rosevear, P. O. Box 1707, Winnipeg, Man.

Western Railway Club (Chicago).—Major Chas. Hine, special representative on the staff of the director of maintenance and operation of the Harriman Lines, and who is in charge of the installation of the "Hine" or "Unit System of Organization," will present a paper on "Organization" at the meeting of January 18th.

At the December meeting W. V. Turner, of the Westinghouse Air Brake Company, gave a lecture, illustrated with lantern slides, on "Brake Manipulation in General Freight Service. A Review of Some of the Causes and Conditions Which Produce Shocks and Break-in-Twos."

Secretary, Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

BOOKS.

Manual for Engineers. Compiled by Prof. Chas. E. Ferris and published by the University of Tennessee, Knoxville, Tenn. Vest pocket size. Price 50 cents.

This is the thirteenth edition; matter used in former editions that seemed to be somewhat obsolete has been replaced by new material. It contains a large amount of data and tabular matter, conveniently arranged for ready reference.

Railroad Pocket Book. By Fred H. Colvin. Second edition. 4 by 6 inches, illustrated, paper bound. Published by The Norman W. Henley Publishing Company, 132 Nassau street, New York City. Price, $1.00.

The information is arranged alphabetically in the form of a dictionary and will be found very convenient for ready reference. It relates largely to the work of the motive power department and is illustrated with a large number of line drawings.

Locomotive Breakdowns and Their Remedies. By Geo. L. Fowler and revised by Wm. W. Wood. Pocket edition, paper cover, 270 pages. Price, $1. Published by The Norman W. Henley Publishing Company, 132 Nassau street, New York City.

The principal change in this, the sixth revised edition, is that the air brake chapter has been rewritten and a chapter of useful rules and information has been added. Walschaert valve gear troubles and the electric headlight are treated in detail.

The "Mechanical World" Pocket Book and Year Book for 1910. Published by Emmott & Co., Ltd., 65 King street, Manchester, England. Price, 15 cents net.

This is the twenty-third edition and contains a collection of engineering notes, rules, tables and data occuping about 230 pages (3¾ x 6 in.). There is also a complete index and about 60 pages for a diary for 1910. The low price of the book is explained by a number of additional pages containing advertisements. A considerable amount of new matter has been added and a thin, tough paper has been used, effecting a considerable reduction in the bulk.

First Annual Report of the Board of Supervising Engineers of Chicago Traction. Published by the Board, Chicago, Ill. 462 pages; 5¾ in. by 8¾ in.; cloth.

The Board of Supervising Engineers is made up of Bion J. Arnold, chairman; George Weston, representing the city of Chicago; Harvey B. Fleming, representing the Chicago City Railway Company; John Z. Murphy, representing the Chicago Railways Company, and F. K. Parke, secretary and auditor. The report is for the period ended January 31, 1908, and is designated as the first annual report. It covers the present condition of the traction systems thoroughly and, of course, to a certain extent outlines the course to be followed in the future.

Betterment Briefs. By Henry W. Jacobs, Assistant Supt. Motive Power, Atchison, Topeka and Santa Fe Railway. 262 pages. 151 illustrations. Published by John Wiley & Sons, New York City. Price, $3.50.

The first edition of this book, which is a collection of published papers on organized industrial efficiency, was prepared by Mr. Jacobs for private circulation and was reviewed at considerable length in the June, 1908, issue of this journal, page 228. The new edition has been revised and enlarged in a manner which may be best described in the words of the preface, prepared by Charles Buxton Going, of *The Engineering Magazine:*

"Meanwhile (since the first edition) the work on the Santa Fé was proceeding to the development of a new order—new, not only to the road, but to the ideals of railroad operation generally. In the mechanical and stores' departments, in the apprenticeship system, and in all the relation with employees, both financial and friendly, standards were being attained which made the Santa Fé a center of observation and study for railway officials throughout the country. Both inside and outside the organization in which Mr. Jacobs was directing so strong a motive force, there was need for a logical presentation of the various aspects and activities of the betterment work—a presentation which should properly correlate the several influences and agencies and show them in their proper proportion and connection with one another.

"This book appears as the fulfilment of the need. While it is recrystallized from a portion of the original material, it is a segregation of the best elements contained therein, strengthened and amplified by a great store of new matter amply sufficient to display the present status of betterment work and to advance its fuller development. It has been prepared at the very focus of the energies with which it deals, and it reflects the actualities as they appear in the daily prosecution of the movement for higher efficiency and better economy in the conduct of a great railway. Above all, it expresses the strong vitality, the watchful intensity, the wide activity, and the energizing personal enthusiasm of its author."

Locomotive Dictionary. Revised 1909 edition. Compiled for the American Railway Master Mechanics' Association by Geo. L. Fowler. 670 pages, 9 in. by 12 in.; 5,266 illustrations. Price, $6. Published by the *Railroad Age Gazette*, New York and Chicago, and by the *Railway Gazette*, London.

The first edition, issued three years ago, has been thoroughly revised. Considerable care has been taken to exclude those designs that have become obsolete. Devices which are still in an experimental stage have also been omitted. This and the fact that the illustrations are exceptionally good makes the volume of special value to those interested in locomotive design and maintenance.

Through an oversight the AMERICAN ENGINEER AND RAILROAD JOURNAL was not properly credited with certain information which was used, but the publishers promptly acknowledged this when they discovered the error, as may be seen from the following extract from their review of the book: "In the latter part of the volume the exhibit of machine tools for locomotive shops is designed to cover the latest and most approved practice. In this connection there is given a study by the distinguished mechanical engineer, L. R. Pomeroy, of the machine tool operations required, working eight hours a day, in making four new consolidation locomotives, eight light repairs and 30 general repairs per month at the Scranton shops of the Delaware, Lackawanna & Western Railroad. It is a thorough piece of work, of high value to any officer looking for shop economies. It might be called an unrelenting piece of work. In an analysis of the results to be expected from machine tools, Mr. Pomeroy has favored no one. In presenting this study, with Mr. Pomeroy's permission, the publishers owe and desire to make a sincere apology for a failure to credit the first serial publication of Mr. Pomeroy's work to the AMERICAN ENGINEER AND RAILROAD JOURNAL. The files of this widely known monthly railway publication were of frequent value to the compiler in obtaining information of new designs."

Railroad Structures and Estimates. By J. W. Orrock, C. E. 270 pages, 6 by 9 inch, cloth. Price, $3. Published by John Wiley & Sons, 43 East 19th street, New York City.

It was the intention of the author to cover in a brief and concise form the subjects which enter into the engineer's estimates of railroad building for the purpose of ready reference, as to general construction and cost, on a business rather than a technical basis. As it is impossible to give data to suit all conditions, the weights, quantities, and cost are given in detail in most instances and may be varied as desired.

The sections of special interest to mechanical department readers are those on engine houses, boiler houses, storehouses, oil houses, coaling stations, ash pits, sand houses, turntables and shops.

PERSONALS.

E. H. Diehl has been appointed traveling engineer of the middle division of the Pennsylvania R. R.

T. H. Yorke has been appointed master mechanic of the Chicago Great Western, with office at Des Moines, Iowa.

R. G. Cox has been appointed master mechanic of the Virginia & Southwestern Ry. to succeed A. J. Dunn.

W. J. Bennett, assistant superintendent of motive power of the Chicago, Indianapolis & Louisville, with office at Lafayette, Ind., has resigned.

John U. Mock has been appointed purchasing agent and assistant treasurer of the Denver, Laramie & Northwestern, with office at Denver, Colo.

N. M. Maine, general master mechanic of the Chicago, Milwaukee & Puget Sound at Deer Lodge, Mont., has been transferred to Tacoma, Wash.

C. M. Stansbury, master mechanic of the Boca & Loyalton at Loyalton, Cal., has been appointed master mechanic of the Western Pacific, with office at Elko, Nev.

G. E. Johnson, master mechanic of the Chicago, Burlington & Quincy at Wymore, Neb., has been appointed general master mechanic, with office at Lincoln, Neb.

J. J. Thomas, Jr., has been appointed superintendent of motive power and car equipment of the Mobile & Ohio, with office at Mobile, Ala., succeeding G. S. McKee, resigned.

John C. Stuart, general manager of the Erie Railroad, has been made vice-president of that road, in charge of the operating, maintenance and mechanical departments.

David Van Alstyne, vice-president of the American Locomotive Company, in charge of manufacture, has resigned.

Thomas Kuhn has been appointed to succeed the late W. J. Ritchie as foreman boilermaker of the Erie's grand division and the New York, Susquehanna & Western, at Jersey City.

Michael W. Hassett has been appointed master mechanic of the New York Central & Hudson River, with office at East Buffalo, N. Y., succeeding F. M. Steele, transferred to Rochester.

C. L. Buchanan has been appointed general storekeeper of the National Railways of Mexico, with office at San Luis Potosi, Mex., succeeding Charles O'Brien, resigned on account of ill health.

E. J. McMahn, general foreman of the Illinois division of the Iron Mountain at Dupo, has resigned to become master mechanic on the Raton Mountain division of the A., T. & S. F. Ry.

C. B. Foster has been appointed general storekeeper of the Toledo, St. Louis & Western, the Chicago & Alton, the Iowa Central and the Minneapolis & St. Louis, with office at Bloomington, Ill.

F. S. Anthony, master mechanic of the International & Great Northern at Palestine, Tex., has been appointed superintendent of machinery, with office at Palestine, succeeding J. F. Enright.

Benjamin Johnson, formerly superintendent of motive power of the Mexican Central, has been appointed superintendent of motive power of the United Railways of Havana, with office at Havana, Cuba.

James W. Stuart, assistant general storekeeper of the Chicago, Burlington & Quincy, has been appointed temporary general storekeeper, with office at Chicago, succeeding Thomas A. Fay, deceased.

George S. McKee, superintendent of motive power and car equipment of the Mobile & Ohio, with office at Mobile, Ala., has resigned. He will continue with the company for some months in an advisory capacity.

J. H. Race has been appointed a master mechanic of the Oregon Short Line, with office at Pocatello, Idaho. He will have charge of the Pocatello shops, including the roundhouse and car department forces.

F. L. Allcott having resigned as engineer of tests of the Chicago, Milwaukee & St. Paul, J. F. De Voy, mechanical engineer, will assume charge of the testing department, in addition to his other duties. Mr. Allcott has gone with the Buckeye Steel Castings Company at Columbus, Ohio.

John M. Lammedee, a graduate of the mechanical engineering department, Purdue University, has resigned the position which he has held for several years in the test department of the Pennsylvania R. R. at Altoona, and joined the editorial staff of *The Railway & Engineering Review*, at the Chicago office.

James W. Friend, of Pittsburgh, died on December 26 at 10.45 P. M. after a lingering illness. He was 64 pears old. Mr. Friend was a familiar figure in the iron, steel and coal industries and among the banking interests of Pittsburgh, having been vice-president of the Pressed Steel Car Company, the Western Steel Car & Foundry Company, one of the owners of the Clinton Iron & Steel Company, vice-president of the German National Bank of Allegheny, and a director in the Farmers' Deposit National Bank of Pittsburgh. The funeral took place on December 29 at 2.30 P. M. from his late residence in Pittsburgh.

Peter H. Peck, for more than 20 years master mechanic of the Chicago & Western Indiana, was struck by a freight train at Seventy-ninth street, near Grand Crossing, Chicago, on November 28, and was so badly injured about the head that he did not regain consciousness and died that evening. A sketch of his career was published in the December, 1909, issue of this journal.

M. H. Haig has been appointed mechanical engineer of the Atchison, Topeka & Santa Fe, with office at Topeka. Mr. Haig was graduated from Cornell University in 1900 and immediately after graduating began railway work with the Illinois Central as a machinist apprentice. He was later a machinist and afterwards a foreman. He resigned in April, 1906, to become editor of the *Railway Master Mechanic*. In February, 1909, he was appointed betterment assistant on the Santa Fe, where he was engaged in work of the bonus department.

H. E. Rouse has been appointed general storekeeper of the Chicago Great Western. He was born August 7, 1868, at Morning View, Ky., and began railway work in March, 1887, with the Cincinnati, New Orleans & Texas Pacific as clerk in the office of the superintendent of motive power and machinery. Later in the same year he was transferred to the accounting department, where he remained six years. He was made chief clerk to the master mechanic and division storekeeper at Chattanooga, Tenn., in September, 1893. In February, 1900, he went with the Chicago & Alton, where he was consecutively, until his recent appointment, chief clerk and accountant for the maintenance of way department, chief clerk and accountant for the motive power department, and general storekeeper, with office at Bloomington, Ill. Mr. Rouse's headquarters will be at Oelwein, Iowa.

Samuel Garver Thomson, who has been appointed assistant engineer of motive power of the Philadelphia & Reading and subsidiary companies, with office at Reading, Pa., was born November 19, 1875, at Cumberland, Md. He was graduated from the Lawrenceville school in 1894 and from Princeton University in 1898. In October of the same year he began railway work with the Pennsylvania and later up to 1902 was a special apprentice at Altoona, Pa. He was then appointed motive power inspector at Altoona, Pa., since which time he has been consecutively general foreman at State Line, assistant master mechanic at Harrisburg, assistant engineer of motive power at Buffalo, N. Y., and later assistant engineer of motive power at Philadelphia, Pa., with the same company. He was appointed assistant engineer of motive power on the Philadelphia & Reading, November 15, 1909.

Dr. C. B. Dudley, chemist of the Pennsylvania Railroad, died at Altoona, Tuesday, December 21. He was born July 14, 1842, at Oxford, N. Y., and was educated at Oxford Academy and Yale University. He was graduated from the academic department of the latter institution in 1871 and from Sheffield Scientific School in 1874. For one year he served as assistant to the professor of physics at the University of Pennsylvania. In 1875 he entered the service of the Pennsylvania Railroad as chemist, which position he held to the time of his death. He was twice elected president of the American Chemical Society and was extremely active in the work of the American Society for Testing Materials. He was several times elected president of this latter society and the important position it occupies at the present time is largely due to his efforts. At the close of its convention last July he was chosen as the official delegate to represent the society at the International Congress for Testing Materials at Copenhagen, Denmark. He was elected president of the International Congress which is to meet in this country in 1912. Dr. Dudley served in the One Hundred and Fourteenth New York Volunteers during the Civil War and was severely wounded in the battle of Winchester, September 19, 1864. He was one of the most prominent scientists in the country and his loss will be widely regretted.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

HEATING SYSTEMS.—"The Selection of a Heating System" is the title of a booklet issued by Warren Webster & Co., Camden, N. J. The Webster Modulation system of steam heating is described and attention is directed to its advantages.

UPRIGHT DRILLS.—J. E. Snyder & Son, Worcester, Mass., have prepared a neat 52-page catalog describing the upright drilling and tapping machines manufactured by them. These drills are from 20 to 26 in. in size and may be equipped with either a belt or motor drive.

MOTOR-GENERATOR SETS.—The functions of the motor-generator set and the methods of choosing the motor-generator best adapted for each condition have been clearly outlined in Bulletin No. 116, published by the Crocker-Wheeler Company, of Ampere, N. J.

FLOATING REAMER HOLDER.—A new floating reamer holder for use in vertical boring mills with turret heads, and which holds any make or style of reamer with Morse taper shank, is described in a circular received from the Colburn Machine Tool Company, Franklin, Pa.

CONVEYING MACHINERY.—Catalog 81 from The Jeffrey Manufacturing Company, Columbus, Ohio, contains general price lists and descriptions of the elevating, conveying and power transmitting machinery, and chains manufactured by them. It contains 368 pages.

SMALL DIRECT CURRENT MOTORS.—Bulletin No. 118 from the Crocker-Wheeler Company, Ampere, N. J., describes their Form L motors which have a capacity of 1/20 to 7½ h. p. A number of typical applications of these motors are illustrated. The last page contains considerable engineering information of value to motor users.

FURNACES.—Bulletin G from the Rockwell Furnace Company, 26 Cortlandt street, New York City, describes both their underfired and overfired furnaces for hardening, tempering, case hardening and annealing tools, etc. A portable accurate temperature furnace using oil fuel; also a complete oil burning outfit and oil or lead bath tempering furnaces with either gas or oil fuel are illustrated and described.

"GRAPHITE AS A LUBRICANT."—The eleventh edition of this well-known publication of the Joseph Dixon Crucible Company, Jersey City, N. J., is ready for distribution. The present edition is more compact than its predecessors, the idea being to concentrate the information into a convenient form for ready reference and not be too bulky. The use of larger type and wider margins greatly improves the appearance of this new edition.

WROUGHT IRON VS. STEEL PIPE.—The Reading Iron Co., Reading, Pa., is issuing the eighth edition of a pamphlet which is in the form of a brief for the plaintiff before a court and contains a full argument why wrought iron is better than steel in resisting corrosion of pipes. It contains extracts of letters from users, articles from technical papers and similar information. The pith of the argument is that the presence of silicate of iron in wrought iron is the reason of its better resistance to corrosion. This pamphlet is most interesting and instructive.

"THE DAWN OF A NEW ERA IN LIGHTING."—In a very attractive pamphlet the General Electric Company takes up the history of light from the tallow dip to the latest development in artificial lighting—the tungsten lamp. Following this historical sketch is a description of the tungsten lamp, its efficiency, cost of operation and various applications of the lamp in interior lighting. The comparison of cost of this with other illuminants is taken up in considerable detail. The pamphlet, which is numbered 3885, is of interest to both the prodocer and consumer of current.

STEAM TURBINES FOR LOW PRESSURE AND MIXED PRESSURE.—Bulletin No. 4705, devoted to the above subject, has been issued by the General Electric Company. The publication deals with turbines of both the low pressure and the mixed pressure types, and those with horizontal and with vertical shafts. Two cases are considered: First, turbines in connection with engines that are run non-condensing; second, in connection with condensing engines. Horizontal turbines of this type are built with capacities of from 300 to 2,000 k. w., and 25 and 60 cycles. Those of 300 and 500 k. w. capacity are also built for direct current. The 5,000 and 7,000 k. w. turbines are vertical and for alternating current only.

SAFETY VALVES.—The Consolidated Safety Valve Company, 85 Liberty street, New York City, has done very effective work in connection with the rating and specifying of safety valves according to their actual relieving capacities, and in increasing their efficiency by modifications in design which made possible the obtaining of larger capacities and a cleaner, more positive action. A cloth bound catalog has been received from this company; it opens with a brief discussion of safety valve capacity and a description of tests that have been made in investigating the subject. Then follows a description of the various designs manufactured by them. Much space is given to valves especially designed and developed for locomotive service.

ASBESTOS PROTECTED METAL.—The Asbestos Protected Metal Company, Canton, Mass., has prepared a catalog which describes in detail the composition of its product and considers at length the various uses for which it is adapted. It is of special interest to the railroads in connection with roofing and siding of buildings, shops and coal tipples; also box car roofing, and roofing, headlining and paneling for steam and electric passenger cars, etc.

INSULATION OF PIPES AND BOILERS.—This is the title of a booklet received from H. W. Johns-Manville Company, 100 William street, New York City. Among the J-M sectional pipe coverings which are illustrated and described are Asbestos-Sponge Felted, Asbestos Fire-Felt, Magnesia, Vitribestos, Asbestocel, Air-Cell, Moulded Asbestos, Wool Felt, Anti-Sweat, Eureka and Zero. Other coverings are the Keystone plumbing pipe covering which prevents dripping and freezing of plumbing pipes, Safety Blow-Off sectional pipe covering for blow-off pipes, Asbestocel corrugated fireproof paper for covering heater pipes, etc., Asbestos Roll Fire-Felt, and sheets and blocks for boilers, boiler flues, heaters, etc. Asbestos and magnesia cements for use with these coverings are described and directions are given for applying them.

WOOD-WORKING MACHINERY.—Catalog L from The Bentel & Margedant Company, Hamilton, Ohio, describes the well-known line of Hamilton-Ohio-Line wood-working tools. It is arranged in a neat and compact form, containing about 200 pages and being 4 x 6¼ in. in size. The illustrations while small are clear-cut and show up the details splendidly. The illustrations are on the left hand page with the description opposite. Some idea of the extent of the catalog may be gained from the fact that it contains almost 200 illustrations.

A number of the tools described have been specially designed for use in car shops. They include car mortisers, car gainers, car borers, car tenoners, car saws and car planers, jointers, wood workers, etc.

HORIZONTAL AND VERTICAL MILLING MACHINES.—The Cincinnati Milling Machine Company, Cincinnati, Ohio, has prepared a new 160-page, standard size, 6 x 9 in. catalog, describing the various lines of horizontal and vertical milling machines made by it. The catalog opens with a carefully prepared and thoroughly, as well as handsomely, illustrated description of the important details of these machines. Then follows illustrations and specifications of each size and type of miller.

A number of pages are used for describing typical examples of rapid milling. Fifty pages are required to illustrate and describe the various attachments used. The book closes with notes concerning the erection and care of millers, and speed tables for high speed steel cutters. These tables are based on a surface speed of 40 feet per minute for annealed tool steel, 80 feet per minute for cast iron and machinery steel, and 120 feet per minute for bronze and brass castings.

A carefully prepared index and the placing of the subjects under discussion in heavy type on the margin of the page make the catalog of special value for reference purposes. Summed up it may be designated as a high grade text book on milling machines.

Some important improvements have been made on the No. 1½, 2 and 3 cone-driven machines, especially in the design of the column and the feed mechanism. The column is very similar to that used on the high power machines, in that it is a complete box in form and contains the entire feed mechanism.

NOTES

THE Q M S CO. (Quincy, Manchester, Sargent), desires to announce that on January 1st they will move their western office from 1775 Old Colony Building to 738 First National Bank Building, Chicago. Their interests in the west will hereafter be taken care of by John C. Hoof.

Q. & C. COMPANY.—G. C. Isbester has been elected vice-president of the Q. & C. Co., and F. F. Kister, treasurer. Mr. C. F. Quincy remains president as heretofore. This company handles the Bonzano rail joint, Q. & C. and National step joints, Q. & C. insulated joint and Anti-rail creeper's, guard rail clamps, guard rail braces, Q. & C. portable rail saw, Q. & C. Samson rail-bender, Maxwell deformed bar, Kimball concrete tie and Bailey lining and surfacing blocks. The western office in charge of vice-president Isbester, will be in the Old Colony building, Chicago.

PAUL M. CHAMBERLAIN announces that he has opened an engineering office at 1522 Marquette Building, Chicago. Mr. Chamberlain was graduated from the Michigan Agricultural College in 1888, and from Cornell University in 1890. For several years he was in practical work with the Brown Hoist Company, of Cleveland, Ohio; the Frick Company, engineers, of Waynesboro, Penn.; the Hercules Iron Works, of Aurora, Ill.; and then accepted the assistant professorship at the Michigan Agricultural College. At the opening of the Lewis Institute, in Chicago, he took charge of the engineering work and brought it up to its well-known standard of excellence. During his connection with the Lewis Institute he carried on much consulting work with special reference to power production and factory methods. He resigned this position to act as consulting engineer for the McCan Mechanical Works, of Los Angeles, Cal. Later he accepted the position as chief engineer of the Under-Feed Stoker Company of America, where for the past two years and a half he has made a special study of boiler room equipment, economy in fuel burning and smoke abatement. He will devote his time to new designs and improvement of existing installations.

THE ELECTRIFICATION OF TRUNK LINES

L. R. Pomeroy.

We are fortunate in being able to present one of the clearest and most logical discussions of the problem of the electrification of trunk lines that has thus far been made. The electrical engineer in discussing the problem has lost sight of many important considerations in connection with the maintenance and operation of the steam locomotive. He has assumed that the tonnage moved was limited by the capacity of the locomotive and has lost sight of the fact that it was controlled by operating conditions, terminal facilities etc.—conditions that will affect the electric locomotive in the same way. The great expense of replacing steam by electricity and the resulting heavy fixed charges have not been given proper emphasis. Mr. Pomeroy has been eminently fair to the electric locomotive and has conservatively stated the case of the steam locomotive; it is believed that his statements will have much to do in clearing away the haze on this subject in the minds of many of our readers, caused to some extent by the many electrical terms—volts, amperes, cycles, alternations, phases, etc., etc.—that usually accompany the arguments of the electrical engineer. These notes are the basis of an address recently given by Mr. Pomeroy before the Engineering Society of Columbia University, New York City.

It is assumed that, from a physical and mechanical viewpoint, electric traction can meet all the demands and requirements of railroad service. Therefore, whether electricity will replace steam traction or not, is entirely a commercial problem.

COMMON DENOMINATOR = COMMERCIAL CONSIDERATIONS*

Electrification Handicapped by Large Outlay.—It may be stated at the outset that whatever system of electrification is adopted, a very large outlay has to be faced and no case for electrification can be made out *unless an increase in net receipts can be secured sufficient to more than pay interest on the extra capital involved.* This increase may be brought about either by decreasing the working expenses for the same service, by so modifying the service as to bring in a greater revenue, or by a combination of these.

Some Sections of Roads Now Operated by Steam Could be Handled Better by a Light Trolley Service.—However, there is hardly a steam road in existence to-day which does not have divisions or sections, where distinctly local traffic can be handled more profitably by light, comparatively frequent electric service, than as now, with heavy steam trains.

Steam and Electric Service Can Be Operated on the Same Track.—Both steam and electric service can be operated over the same tracks without detriment or embarrassment to either. In so doing each kind of service would be appropriately handled in a manner best suited to the conditions of each.

The fundamental principle, based on the present state of the art, seems to be, that if you cannot accomplish something by means of electricity that is now impossible by steam traction, there is nothing to justify the change; the mere substitution of one kind of power for another, merely to obtain the same result, is not commercially warranted.

An Inherent Advantage of Electricity Not Available for Trunk Line Service.—There are certain inherent advantages in electrical operation that have shown up advantageously, because the increase in business has absorbed the increased interest account, but these cases hardly apply to trunk line conditions as the law of induced travel has no bearing on freight train operation, the principal business of trunk line roads.

Boiler the Limiting Feature of the Steam Locomotive.—In heavy work the limiting feature of the steam locomotive is the boiler, and the maximum adhesion can be utilized only at low speeds. For example, a 2-8-0 locomotive with 180,000 pounds on the drivers, has a tractive force, at 10 miles per hour, of about 40,000 pounds, or 4.5 to 1. At 30 miles per hour the tractive force becomes 13,250 pounds, or 30.2 to 1. As tractive force governs the tonnage hauled, the ability of the electric locomotive to utilize almost indefinitely power proportional to the maximum adhesion and produce a drawbar pull entirely independent of the critical speed of a steam locomotive, as limited by the boiler, is a marked feature.

Electric Locomotive Valuable for Heavy Grade Work.—In heavy grade work the ability to increase the speed shows up favorable to the electric locomotive as enlarging the capacity of a given section, but here also the business has to be sufficient to absorb the increase in fixed charges.

Coal Consumption of Steam Locomotive per Horse Power Hour.—With steam locomotives a coal consumption, when running, of 4 to 5 pounds per indicated horse-power really means 6 or 7 pounds at the rail, when the losses due to firing up, laying by in yards and sidings, blowing off at the pops, and consumption of the air pumps, is taken into account. Whereas, under electric operation, with an efficiency of 65 to 70 per cent. between the power house and the rail, a coal consumption of 4 pounds per kilowatt hour at the rail can be counted on.

Cost of Power for Electrical Operation.—The writer is informed that the Metropolitan Street Railway station (1903) with a 40 per cent. load factor, produced power, at the switchboard,

* Recently the *Engineer* (London) editorially made a plea for a "Common Denominator" for comparison of engineering achievements, using the following illustrations:

"Thus for example, if we take Mr. Humphrey's reply to Mr. Davey's criticisms, we see that he gained a mere dialectical advantage by showing on the screen a great differential pump, and beside it an internal combustion pump, so small by comparison that he had to explain that it was not a "hooter." Both engines could deal with the same quantity of water; but the Davey engine was lifting it 1,500 ft. from a mine, while the gas pump could not lift it more than about 15 ft. Indeed, it could not do the work of the Davey engine at all."

Also a comparison was drawn between the cost of working with producer gas engines and steam engines. The argument was all in favor of the gas engine, expressed in weight of fuel required per hour to develop a horse-power. But the aspect of the matter changed when it was pointed out that the coal used by the steam engine was slack, costing $1.75 per ton, while the gas producer worked with anthracite, costing over $6.25 a ton. Here the cost of fuel was the common denominator, not the weight of the fuel.

The plea concluded by saying that the common denominator should be the Commercial Cost. E. H. McHenry expressed the same idea when he said that "Engineering was making a dollar earn the most interest."

at the rate of 4.7 mills per kilowatt hour (or 3.5 mills per horse-power hour) and with a load factor of 55 per cent. which prevails in the winter time, the cost is at the rate of 4.43 and 3.3 mills respectively. These costs cover all expenses and repairs except fixed charges. The coal consumption is 2.9 pounds per kilowatt and 2.16 per horse-power hour.

L. B. Stillwell is authority for the statement that the Interborough is producing power at the rate of 2.6 pounds of coal per kilowatt hour or 3 pounds at the drawbar.

Another authority gives the following figures for the elevated roads for cost of power, $0.005 per kilowatt hour at the switchboard, $0.0066 at the third rail shoes, or $0.0089 at the rims of the drivers. These figures are exceptional and hard to duplicate and as the fixed charges are not included, the writer *would consider 1¼ cents per kilowatt hour at the rail a conservative figure and will use this cost in the following computations.*

Relative Cost of Coal for Steam and Electrical Operation.—It may be fair to assume that where average coal is used, we can count on about $2.25 per ton for locomotive coal on the tender, while a much cheaper grade can be used in the power house, costing, with modern coal handling facilities, about $1.50 per ton. At this rate the relative difference in the cost of coal at the rail would be represented by the following figures:

Electric Power Station $\dfrac{2.5 \text{ lbs.}}{50\% \text{ eff.}} \times \$1.50$ $7.50

Steam Locomotive $7 \times \$2.25$ $15.75

or 50 per cent. in favor of electricity. The following results of the Mersey Tunnel operation are pertinent: Under electric operation one ton of coal at $2.10 yields 2.29 ton miles at 22½ m.p.h., while with steam, one ton of coal, at $3.84, yields 2.21 ton mines at 17¾ m.p.h. The difference amounts to 55 per cent. in favor of the electric operation.

$$\left[1-\frac{2.10}{3.84}\right] \times \frac{22.5}{2.29} \div \frac{17.75}{2.21} = \left[1-\frac{2.10}{3.84}\right] \times \frac{22.5 \times 2.21}{2.29 \times 17.75} = 55\%$$

Advantage in Cost of Fuel for Electricity Still Greater on Mountain Grades or in Heavy Freight Service.*—While perhaps the difference in cost does not become so great, in ordinary working of low grade lines, although some of the most powerful passenger locomotives in the country are used on such lines, yet on mountain grades or in heavy freight service, where the boiler of the freight locomotive is forced to the limit, and the boilers are designed for this particular purpose, the showing is more favorable to the electric side; especially when the steam locomotive is detained on side tracks as long a period as it takes to make the run, which is very frequently the case, as under these conditions the cost for fuel becomes a larger proportion of the total operating expense. A 2-8-0 locomotive with 50 square feet of grate surface burns 300 pounds of coal per hour while lying on side tracks. Reports from Mallet locomotives indicate that from 600 to 800 lbs. are burned per hour.

The cost of a unit of power, with the steam locomotive, becomes relatively higher under maximum than minimum boiler demands, while with electricity the cost per unit is at a uniform rate, whether working under extreme or light power demands.

For example:

Case 1. A consolidation (2-8-0) type locomotive with 180,000 pounds on 57 inch drivers, 50 square feet of grate surface, working under maximum conditions on a 1½ per cent. grade, would burn 150 pounds of coal per square foot of grate surface per hour and evaporate from 12 to 15 pounds of water per square foot of heating surface per hour.

Under these conditions the cost per 1,000 ton miles would figure out as follows:

$$\frac{F \times \text{price per ton} \times R \times 1000}{2000 \times \text{M.P.H.} \times E \times TF} = \text{Cost per 1,000 ton miles.}$$

where F = coal per hour (150 lbs. × 50 sq. ft. of grate surface).
R = resistance to be overcome [(grade per cent. × 20) plus 6].
E = 80 per cent. efficiency to cover losses such as cleaning fires, idle time while under steam, cylinder condensation, air pump consumption, etc.
TF = tractive force, in this case 180,000 lbs. on drivers ÷ 4.5 = 40,000 lbs.

Substituting these values, the formula becomes:

$$\frac{7{,}500 \text{ lbs.} \times \$2.85 \times 36 \times 1{,}000}{2{,}000 \times 10 \times 80\% \times 40{,}000} = \$1.20$$

If the same service is handled by electric locomotives, the cost on a similar basis becomes:

$$\frac{R \times (\text{watt hrs. per ton mile}) \times 1{,}000 \text{ tons} \times \text{price per kw. at the rail}}{1{,}000 \text{ watts}}$$

$$= \frac{36 \times 2 \times 1{,}000 \times \$0.01\tfrac{1}{4}}{1{,}000} = \$0.90$$

If locomotive coal is taken at $1.70 per ton (the price in eastern Pennsylvania for low grade soft coal), the cost for coal for locomotives under the foregoing conditions would be:

(a) Steam, $\dfrac{\$1.20 \times 1.70}{2.85} = \$0.716$

(b) Electric current reduced to 1c. per kw. hour at the rail:

$$\frac{0.90 \times 1\text{c.}}{1\tfrac{1}{4}\text{c.}} = \$0.72$$

Case No. 2. An express passenger locomotive of the Atlantic (4-4-2) type, with the following data: Cylinders 21x26 inches, boiler pressure 200 pounds per square inch; weight on drivers 102,000 pounds, heating surface 2,821 square feet, grate surface 50 square feet, rate of combustion 150 pounds per square foot of grate surface per hour, speed 70 miles per hour. Figuring as in Case No. 1:

$$\frac{7{,}500 \times 2.85 \times 20 \times 1{,}000}{2{,}000 \times 70 \times 80\% \times 5{,}350} = \$0.71$$

Under electric conditions we have:

$$\frac{20 \times 2 \times \$0.01\tfrac{1}{4} \times 1{,}000 \text{ tons}}{1{,}000 \text{ watts}} = \$0.50$$

or 28½ per cent. less.

If coal is taken at $1.70 per ton, as in Case 1, the cost is reduced from $0.71 to $0.42, making the difference slightly in favor of steam.

These figures apply only to the conditions named, and average conditions, on an undulating profile, when coasting is occasionally possible, and also with the benefits of momentum grades, the figures would be relatively less, but the electric locomotive will respond and benefit accordingly, so that the percentages given would be approximately the same.

When steam locomotives are loaded to their capacity, as is generally the case where tonnage rating is practiced, the rate of combustion of 150 pounds of coal per square foot of grate surface per hour, will still hold good and remain constant, the tons hauled being the variable, responding or being modified by the speed or physical conditions of the road.

Savings Claimed for Electrification.—In view of the foregoing the following extract from an article by Mr. C. L. De Muralt will be of interest; the figures given are from the annual report of 1903 of the roads named:

COST OF OPERATING TRUNK LINES.

	P. R. R.	N. Y. C.
Fuel for locomotives	$6,000,135	$4,635,877
Water " "	335,286	295,583
Other supplies for locomotives	382,548	334,673
Wages:—		
Engine men and roundhouse men	5,716,848	4,928,443
Other train men	4,442,127	2,991,336
Switchmen, flagmen and watchmen	3,900,427	2,611,552
Other exp. conduct. transp.	14,640,542	11,607,638
Repairs to locomotives	4,412,983	3,608,972
" other equipment	10,674,726	5,661,992
" roadbed	8,642,935	6,145,341
" structures	4,122,018	2,454,691
General expenses	1,858,319	1,786,494
	$64,928,894	$46,962,491

Mr. De Muralt then applies the figures found during the

* Commenting on the problem of electrification of the Central Pacific over the Sierras, Mr. Kruttschnitt says: "Eastern critics may be inclined to the opinion that we are dallying with this matter. We have found that it pays well to make haste slowly with regard to innovations. Electrification for mountain traffic does not carry the same appeal that it did two years ago. Oil burning locomotives are solving the problem very satisfactorily. Each Mallet compound locomotive, having a horsepower in excess of 3,000, hauls as great a load as two of former types, burning 10 per cent. less fuel and consuming 50 per cent. less water."—*Wall Street Journal*

course of his investigation, which would lead to the following reductions if electricity was adopted as a motive power:

	P. R. R.	N. Y. C.
Fuel 10% or	$600,013	$463,388
Water saved entirely	335,256	295,583
Other supplies 50%	191,274	167,336
Wages enginemen, etc., 25%	1,429,212	1,207,361
Repairs to locomotives	2,206,492	1,804,486
Total amount saved	$4,762,277	$3,942,154

The *saving in water alone capitalized* at 5 per cent. equals $6,750,000 for the former and nearly $6,000,000 for the latter road. *As large as these alleged savings are, yet they would not amount to more than 2½ to 3 per cent. on the necessary increase in capital to electrify the roads on which the foregoing savings apply.*

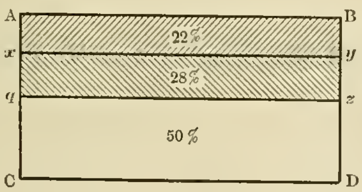
Cost of Repairs of Steam and Electric Locomotives.—While the first cost for power stations and electric equipment represents a large outlay, yet such items as the cost for repairs of locomotives and shops, expensive hostlering at terminals, coaling and water stations and the incidental labor charge and repairs thereto will, in the aggregate, be materially reduced. The comparative saving in repairs will be indicated by the following figures:

Repairs.	Steam.	Electric.
Boiler	20%	0
Running gear	20%	20%
Machinery	30%	15%
Lagging and painting	12%	5%
Smoke box	5%	0
Tender	13%	0
	100%	40%

Comparative Mileage of Steam and Electric Locomotives.—It is further claimed that, with electric operation, greater mileage is possible with the electric locomotive and that fewer units are necessary to perform the same service. Great stress is laid on the fact that the ordinary freight locomotive only makes 3,000 miles per month, or 100 miles per day, against which is put forward the ability of the electric locomotive to perform practically continuous service, suggesting the propriety of comparing electric and steam operation on the basis of ton miles per annum each is able to make and also the relative weight on driving wheels and not as to their total weight.

Operating Efficiency of Steam Locomotive Limited By Operating and Traffic Conditions, and Not by the Locomotive.—The operating efficiency of a steam locomotive in freight service is so low, averaging about 3,000 miles per month, that it is generally thought due to limitations, *per se*, in the locomotive, whereas it is mainly due to operating and traffic conditions, which limitations would apply with equal force to the electric locomotive, so that, barring some increase in speed, the electric locomotive can make no greater mileage than its steam competitor in equivalent service, consequently its splendid ability to perform almost continuous service cannot be realized in practice for reasons aforesaid.

Let the rectangle A, B, C, D represent a day of 24 hours. The shaded area A, B, x, y that portion of the time for which



the mechanical department is responsible—22 per cent., the area x, y, q, z, the average time the locomotive is performing useful work—28 per cent.—*i. e.,* actually pulling trains, 3,000 miles per month, 100 miles per day, while the portion of the diagram bounded by q, z, C, D the period or balance of the time that the locomotive is under steam, with crew, and ready to go, and represents the time at terminal yards, side tracks and awaiting orders, etc. (50 per cent.).

It is just here that our electrical friends make the great mistake of claiming "greater capacity" for the electric locomotive over its steam equivalent. It is conceded that under electric conditions the area A, B, x, y may be reduced as much as one-half and perhaps, owing to greater speed, the area x, y, q, z may be increased, but the "lost motion" period due to traffic and operating causes will be relatively the same for both.

The percentages are from an actual three months' test on a trunk line and reported in 1904 in the A. Ry. M. M. Association by the committee on time service of locomotives.

The only cases where electric operation is commercially justified is in congested local passenger situations where the conditions closely approach a "moving sidewalk" condition, and the records show that these cases have been profitable only when a large increase in business has been realized.

Comparative Dead Weight of Steam and Electric Locomotives.—A modern Atlantic (4-4-2) type locomotive weighs, including tender, 321,620 pounds, with a maximum tractive force of 23,500 pounds. The ratio of total weight to tractive power is 13.3 to 1. The New York Central electric locomotive, with a total weight of 192,000 pounds and a tractive effort of 27,500 pounds, has a ratio of 7 to 1. The comparison is still more favorable for electric freight locomotives where the entire weight is on the driving wheels.

Electric Power Station Capacity Based on Average of Number of Trains in Service, Not the Aggregate.—The impression is quite prevalent that if 100 steam locomotives are required to operate a certain division, if operated electrically, a power station capacity the equivalent of 100 locomotives would be necessary, whereas the generator capacity, barring the installation of spare units, would be of such size as to meet the average load. This average can be determined by laying down a train sheet, from which the load at any hour in the day can be seen and the peaks located.

For ordinary computations the number of trains to provide for is, approximately,

$$\frac{\text{The total train miles per hour}}{\text{Mean speed}}$$

This formula is the result of cancellation from the following:

(a) H. P. days ÷ Aggregate H. P. *i. e.,*

$$\text{(b)}\quad \frac{5{,}280 \times (\text{Dis. miles}) \times (\text{No. trains}) \times (\text{Tons}) \times R}{47{,}520{,}000 \text{ ft. lbs. in 1 day}} \div \frac{\text{Tons} \times R \times \text{m.p.h.}}{375}$$

R = resistance due to gravity, plus resistance due to speed, plus curve resistance.

Transposing and cancelling:

$$\text{(c)}\quad \frac{\text{Dis. miles} \times \text{No. trains}}{24 \times \text{m.p.h.}} = \text{No. trains to provide for.}$$

For illustration take a typical case:—

Distance 183 miles.

Load { 37 Freight Trains at 15 m.p.h.
22 Expresses at 50 m.p.h.
21 Locals at 30 m.p.h.
80 Trains total.

Average speed	37 × 15 m.p.h. =	555
	22 × 50 m.p.h. =	1,100
	21 × 30 m.p.h. =	630
	80	2,285

2,285 ÷ 80 = 28 average m. p. h.

$$\frac{80 \text{ trains} \times 183 \text{ miles}}{24 \text{ hrs.} \times 28 \text{ m.p.h.}} = 22 \text{ trains.}$$

For more accurate work a train sheet should be made either with miles as ordinates and time as abscissæ, or one with trains as ordinates on a time (abscissa) base.

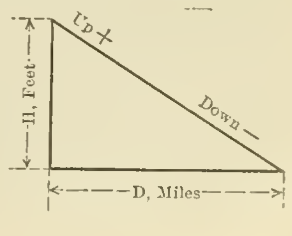
Train Resistance.—Relative to "R" (*i. e.,* resistance) for gravity; divide profile into sections, one for each change in grade plus or minus as the case may be:

$$\frac{H}{D \times 52.8} = \text{Per Cent.}$$

Each 1% grade = 20 lbs. = R.

R for curves 0.56 lbs. per degree.

$$R \text{ for level sections} = 2 \text{ plus } \frac{\text{m.p.h.}}{4}$$



From Power House Viewpoint, More Economical to have Many Trains than to have Same Tonnage in a Few Heavy Trains.—Consider the example of a road or division 100 miles long on which a given train requires 2,000 horse-power to keep it in motion. If 20 cars take a maximum of 100 horse-power each, the electrical conductors and distributing apparatus will never be required to deliver more than 100 horse-power at any one point. If, on the other hand, the entire traffic of the line must be concentrated in a single train, the electrical conductors and distributing apparatus must deliver the full 2,000 horse-power at each and every point. In other words, with the concentrated load, the capacity of the distributing apparatus at each and every point must be 20 times as great as the capacity when 20 cars are used to give the same total load. Electric traction has proven its superiority for distributed loads, but concentrated loads are still handled almost exclusively by steam locomotives.

Electric Locomotives Efficient Where Traffic is Dense.—In the annual report of the P. R. R. (1903) the President states: "That the congested condition of your system has brought about a large increase in the ton mile cost, which for 1903 was 25 per cent. greater than for 1899. In order to prevent the increase in ton mile cost, it is necessary to move freight trains faster in places where traffic is dense, and for such purpose the electric locomotive is most efficient."

Greater Power and Overload Capacity Afforded by the Electric Locomotive.—With steam locomotives the most economical average speed, for freight service, is 12 to 15 miles per hour, where there is ample track space for the free movement of trains. With a dense traffic this free movement can only be obtained by a higher speed, and if the large train tonnage be maintained, more horse-power is required of the engine and boiler. It is difficult to increase the size of steam freight locomotives without resorting to the Mallet compound articulated type, and here we have the equivalent of two locomotives in one machine.

With the electric locomotive it is possible to develop a much greater horse-power and a large percentage of overload at the time when needed and do it more economically than with steam. The New York Central electric locomotive has a maximum peak horse-power of 3,000 which is 25 per cent. above normal. This maximum is about double the power which can be obtained from the New York Central standard Atlantic (4-4-2) type locomotive. Similar proportions can be obtained for electric freight locomotives and their size and power are not limited by boiler capacity. If the steam locomotive is capable of developing 30,000 T. F. at the drawbar at 12 m.p.h., or

$$\left(\frac{30{,}000 \times 12 \text{ m.p.h.}}{375}\right) = 960 \text{ h.p.}$$

and it is required to increase the speed of the train to 20 m.p.h. and maintain the same tonnage, then 1,600 horse-power will be required, which means the employment of a much larger locomotive or double heading.

The advantage of the overload capacity on short mountain grades or for strategic peaks is one of the strong points in favor of the electric machine and would make electric operation applicable to special cases rather than a universal substitute, in the broad light of commercial considerations.

General Conclusions.—Our conclusion, from this survey of the situation, is that the rapid development of suburban passenger traction by electricity will require large power houses at large cities and these can gradually be made sufficient for working the line on further stretches in each direction, handling congested terminals, or used where commercially practicable, until it may be desirable to electrify the entire division.

Electric operation as compared with steam shows to greatest advantage in urban and suburban passenger service. Here, if multiple unit trains are employed, so that a considerable fraction of the total weight is carried on the driving wheels, thus permitting a high rate of acceleration to be used, a schedule speed quite impracticable in steam operation can be maintained. Moreover, a more frequent service can be given without a proportional increase in expense, whilst in times of light traffic small trains can be run, the energy consumption per train in such service being almost in proportion to the number of coaches. *The law of induced travel, however, applies to urban and suburban passenger service, but does not hold for trunk lines and especially freight service.*

How to Determine Whether Expenditures for Improvements Are Justifiable.—Under trunk line conditions the only thing that interests railway managers is the traffic available at the present, relatively speaking; the future is too indefinite to be capitalized to any great degree in advance. It is more in the line of insurance companies to "capitalize expectations."

In grade revision the *authorization for expenditure* is based on the *saving in train miles capitalized.* The following is a concrete case from a western road, or rather the summation of the engineers' report as to just what the proposed rearrangement would amount to. The rate of 50 cents per train mile is to cover those items of cost directly affected by the change.

$$\left\{\begin{array}{l}\text{No. of}\\ \text{trains per}\\ \text{day—7}\end{array}\right\} \times \left[1 - \frac{1{,}350 \text{ tons present conditions}}{1{,}600 \text{ tons proposed}}\right] \times \left\{\begin{array}{c}\text{Div. of}\\ 225\\ \text{Miles}\end{array}\right\} \times 50\text{c.} \times \left\{\begin{array}{c}365\\ \text{days}\end{array}\right\} = \$45{,}990$$

Under the circumstances it will be seen that the value of 1 per cent. reduction in train mileage, per mile, per train, amounts to $1.95 per annum. The total amount capitalized at 5 per cent. equals $919,800. In some such manner the steam railroad manager arranges the proposition of the electric scheme and decides accordingly.

Results of New York Central Electrification.—In a paper before the American Society of Civil Engineers, by W. J. Wilgus, some interesting data concerning New York Central operation was given.

Cost of coal per 2,000 lbs. anthracite steam loco., terminal service....	$4.46
" " bituminous coal, road service....	3.12
" " " " power station....	2.72
Water per 1,000 gallons:—	
Power station	13½ cts.
Road service	5 "

Cost of current, when power station designed load is attained, 2.6 cents per kilowatt hour delivered at contact shoes. This includes all operating and maintenance costs, interest on the electrical investment required to produce and deliver current, depreciation, taxes, insurance and transmission losses.

Items	Operating Costs	Fixed Charges	Total
Power Station....	0.58 cts.	0.44 cts.	1.02 cts.
Transmission Losses....	0.19 cts.	0.15 cts.	0 34 cts.
Distribution Systems and Sub-Stations	0.32 cts.	0.92 cts.	1 24 cts.
Totals....	1.09 cts.	1.51 cts.	2.60 cts.

ROAD SERVICE COSTS PER 1,000 CAR TON MILES.
(Page 102, Vol. LXI, Trans. A. S. C. E.)
(Discussion by G. R. Henderson.)

	Steam	Electric
Supplies....	$2.03	$1.37
Wages....	0.28	0 31
Interest, depreciation, and repairs to locomotive....	0.46	0.34
	$2.77	$2 02

The item "Electric Supplies" is composed of operating expenses and fixed charges and may be analyzed thus:

53.3 kw. hour at $0.0109, $0.58 operation
52.3 kw. " " 0.0151, 0.79 fixed charges
52.3 kw. " " 0.026, 1.37

[Fixed charges = $(\frac{0.79}{1.37})$ or 57% of operating expenses.] *The brackets are ours.*

The difference in cost between steam and electric traction in road service is $2.77 — 2.02 = $0.75 per 1,000 car ton miles.

The fixed charges on the power plant and the transmission system are $0.79 per 1,000 car ton miles, or about the same as the saving, so that if the train movement was but one-half the assumed amount (averaging 6,000 horse-power at the rails, or 6,000 kilowatts at the station) the cost for electric service would be slightly higher than for steam, or $2.81 as against $2.77 per 1,000 car ton miles.

Manhattan Elevated Results.—The Manhattan Elevated, with about 38 miles of road, was electrified at an expense of $17,000,000. The operating ratio, under electric conditions, has been reduced from 61 to 46 per cent. of gross receipts. The net results after taking care of the increased capital, etc., *shows 15 per cent. profit, but it is a significant fact that the increase in business was 46 per cent.* (carrying about 250,000,000 people per annum 690,000 per day average, or 28,800 per hour).

Mersey Tunnel Results.—There has just been reported the four years electric operating results of the Mersey Tunnel road connecting Liverpool and Birkinhead. The net profit, allowing interest, etc., on the increased capital due to electrification, amounted to 15 per cent., but it took an increase in traffic of 55 per cent. to make this operating result possible. Ton miles increased from 43 to 67 million, or 55 per cent. Total expenses, including interest on electric capital (but not depreciation) equals 0.586 per ton mile. Interest equals $0.106 per ton mile, or 22 per cent. of operating expenses.

President Harahan on Proposed Electrification of the Illinois Central.—President Harahan of the Illinois Central reports the results of the investigation that has been made relative to the proposed electrification in the following words:

"Our suburban traffic is the only service which would in any degree be adapted to electric operation, but even in this particular service it can be readily shown to be unjustifiable at the present time. I submit below a statement of the results which are estimated to accrue if the entire suburban service were electrified, compared with the present steam operation:

"Results of Operation of Suburban Business at Chicago for Fiscal Year ending June 30th, 1909:

Gross earnings		$1,056,446
Operating expenses (82.9%) plus taxes		946,734
Net revenue		$109,712
"Estimated Results Under Electrification:—		
Gross earnings		$1,056,446
Operating expenses (66%)	$697,254	
Taxes	74,427	
		771,681
Net revenue (electric operation)		$284,765
Net revenue (steam operation)		109,712
Increase		$175,053
Estimated cost of electrification		$8,000,000
Interest and depreciation 10%		800,000
Saving in operation under electrification		175,053
Deficit		$624,947

"Our suburban traffic is not sufficiently dense to warrant the expense necessary to electrify these lines, and it is evident from the foregoing figures that even under electrification there would not be an increase in traffic sufficiently large to offset the annual loss from operation. It simply proves that under present conditions of cost of electrification of steam railways, where it means a replacement of a plant already installed, and serving the purpose, it is not justifiable to electrify either in whole or in part your Chicago terminals at this time."

The suburban district of the Illinois Central covers about 50 miles of road and carries in round numbers 15,000,000 suburban passengers per annum, or an average of 41,150 per day, or 1,700 per hour. *An increase of 100 per cent. in earnings would not enable the road to break even.*

The Railway Age Gazette, in commenting editorially on Mr. Harahan's statement, says:

"It may be accepted as conclusively demonstrated that the New York Central and the New Haven roads are moving trains by electricity more economically than they moved them by steam, in their suburban district. To enable this to be brought about, however, extremely heavy capital costs had to be assumed and the charges on these capital costs make the entire operating cost, including overhead charge, far higher than it used to be in the days of steam operation.

"For example, a standard express train of eight cars on the New Haven road pulls out of Grand Central station headed by two half unit electric locomotives, each of which cost very nearly $40,000. The capital cost of the motive power of this train is in excess of $75,000 (the interest and depreciation amounting to $20 per day)—the brackets are ours. The cost of motive power at the head of a similar New York Central passenger train operated by electricity is about one-half this sum. Moreover, it will be recalled that Mr. Wilgus estimated that the direct costs of electrical equipment represented only one-fourth of the total charges attendant upon electricity. The cost of making everything ready and safe for this kind of operation is far greater than the highest estimates are apt to contemplate."

Boston & Albany Electrification.—From a report of the Electrical Commission of the State of Massachusetts the following extracts are taken (letter of C. S. Mellen, president of the New Haven road):

"We believe we are warranted in saying that our electric installation is a success from the standpoint of handling the business in question efficiently and with reasonable satisfaction, and we believe we have arrived at the point where we can truthfully say that the interruptions to our service are no greater, nor more frequent, than was the case when steam was in use. *But we are not prepared to state that there is any economy in the substitution of electrical traction for steam; on the contrary, we believe the expense is very much greater.*"

The Boston & Albany Railroad Company reports the result of their study and estimates the requirements as follows: A power station of 6,000 kilowatts will be necessary, with storage batteries to handle the peak load. The total cost of the installation is estimated at $4,000,000, and the interest, taxes and depreciation at 9 per cent., or about $400,000 per annum. A stock argument for electric operation is the saving to be made in operating expenses, but concerning this the following statement is made:

"Some slight economies would accrue in the transportation expenses under this operation which would be substantially absorbed by the additional expenses to be incurred for the maintenance of the additional apparatus installed and the net economies would be so small as to be inappreciable in the consideration."

Another stock argument of the advocates of electric locomotives is the growth of traffic which is supposed to result from electric operation. This argument is met as follows in the report:

"Considering now the possibilities of increasing the traffic, the statistics of the B. & A. R. R. show substantially the following number of passengers handled in the above territory per annum:

1891	4,552,918	1899	3,897,364
1894	4,799,578	1907	4,435,841

"The absence of any material increase in traffic is probably due to the fact that the circuit is occupied as a high class residential district not susceptible of rapid subdivision of property, and more particularly to the fact that suburban lines are being rapidly extended into all such outlying districts and afford a more advantageous means of collecting and distributing local travel through the commercial and residential districts than could possibly be afforded by a railroad constructed and operated upon private right of way and devoted largely to long haul operations."

Illustration Showing How to Determine Whether Steam or Electrical Operation is Best Suited for a Given Set of Conditions

The following illustration representing a concrete case is selected because of its elementary character, more especially as the case is so simple that all the variables effecting the comparison are eliminated and the amount of coal to perform the operation is directly known: Conditions, 1,600 tons, trailing load; average grade, 1.3 per cent.; distance, 8 miles; speed, 15 m. p. h. for electric and 14 m. p. h. for steam locomotive.

(a) Electric.

1,600 net tons	R =	1.3% grade × 20 =	26 lbs.
190 Loco. (2) tons		5° curves	3 lbs.
1,790 gross tons		Level	6 lbs.

$$\frac{\text{(Gross tons} \times \text{R} \times \text{Distance)}}{500} = \text{kw. hours at the rail}$$

Substituting values:

$$\frac{1{,}790 \times 35 \times 8}{500} = 1{,}000 \text{ kw. hours (at rail).}$$

Equivalent kw. load at power house =

$$\frac{\text{Tons} \times \text{R} \times \text{m.p.h.}}{500 \times \text{Eff. per cent.}}$$

Where the efficiency between rail and generators equals 65%, substituting as before:

$$\frac{1{,}790 \times 35 \times 15}{500 \times 65\%} = 2{,}900 \text{ kw.}$$

For this particular case current can be purchased from an adjacent power house at the very low rate of 1 ct. per kw. hr. at the rail.

At this rate the power cost per trip will be 1,000 kw. at 1c., $10.00.

(b) Under steam conditions we have the same as before, 1,600 net tons plus weight of 2 locomotives, 300, or 1,900 gross tons.

The coal consumption for this particular run is 6,000 lbs.

The price per ton to equal the electric cost for power, is:

$$\frac{6{,}000 \text{ lbs.} \times \text{price per ton}}{2{,}000} = \$10.00$$

Transposing:

$$\frac{2{,}000 \times 10}{6{,}000} = \$3.33$$

But as coal for this particular case costs the road $1.70 per ton, the relative cost, coal against power, is

$$\frac{6{,}000 \times 1.70}{2{,}000} = \$5.10$$

There is a difference in ton mile hours, in favor of the electric locomotive, due to speed and reduced gross tonnage, as follows:

$$\text{1st. Electric } \frac{1{,}790 \times 8 \times 8}{15} = 7{,}640 \text{ Gross T. M. hours}$$

$$\text{2nd. Steam } \frac{1{,}900 \times 8 \times 8}{14} = 8{,}690 \text{ Gross T. M. hours}$$

To make the comparison correct the coal consumption of the steam locomotive should be proportioned on the T. M. hours produced, and the cost of coal then becomes:

$$\frac{\$5.10 \times 8{,}690}{7{,}640} = \$5.80$$

Adding to the foregoing the other operating costs the relative expense becomes:

(a) Electric. Power $10.00

Lubrication, supplies, repairs, crew at $0.1158 per 1,000 ton miles, or

$$\frac{0.1158 \times 1{,}790 \times 8}{1{,}000} = \text{............ } 1.66$$

Interest and depreciation, taxes, ins., etc., at 10%... 1.46

$13.12

(b) Steam. Coal as above.. $5.80

Lubrication, supplies, water, repairs, enginemen at 25 cts. per 1,000 ton miles,

$$\frac{\$0.25 \times 1{,}900 \times 8 \text{ miles}}{1{,}000} = \text{.......... } 3.80$$

Interest and depreciation at 10% (2 locomotives)

$$\frac{\$34{,}000 \times 10\% \times 8}{365 \times 24 \times 14} = \text{............ } .22$$

$9.82

Cost per trip in favor of steam, $3.30, or 25% less.

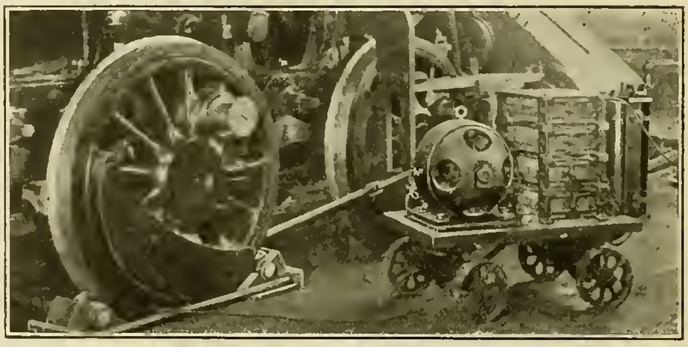
* * * *

The idea is all too prevalent with the public, and even with some of the bodies that have been given legal power of supervision over railway companies, that any expenditure which can be forced upon the railway companies is just so much gain for the public. Never was there a more absolute fallacy. In the long run, the cost of every bit of railway improvement must be paid for by those who buy tickets and ship freight. Economy in the administration of our railways is just as important in the interest of the general public as if the railways were actually under government ownership.

ELECTRIC VALVE SETTING MACHINE.

A 7 h.p. electric motor, mounted on a small cart together with the resistance grids and controller, connected through a shaft with two universal joints and a sliding joint to the driving mechanism of a valve setting machine, is shown in the accompanying illustration. This arrangement is in use at the Collinwood shops of the Lake Shore & Michigan Southern Railroad. This electric drive obtains its current through a flexible cable from the socket for portable lights between the pits and is quickly and easily connected to the valve setting machine.

A driving mechanism of this kind has many advantages for



ELECTRIC DRIVEN VALVE SETTING MACHINE.

use in a shop. It permits a very delicate and accurate movement of the wheel; controlled by a man on the floor who, part of the time, can watch the points of the tram. It also permits of a large variation in speed and has an absolutely positive drive. Another advantage, in many places, is the saving in air. Where electric power is available it is cheaper as a source of energy than the compressed air if the compressors are working to their maximum capacity, as is usually the case in large shops.

ELECTRIC VS. OXY-ACETYLENE WELDING.

The following notes are taken from an article in the *Electro-Chemical and Metallurgical Industry:*

It has been stated that electric welding is more efficient and economical for most purposes than oxy-acetylene welding. This is, however, not strictly correct. The first cost of an electric welding apparatus is incomparably greater than that of an oxy-acetylene welding apparatus. It is also far less portable, and its scope is consequently more restricted. There are certain applications for which electric welding may be more suitable, but for ordinary every-day work there can be no doubt that the oxy-acetylene system is much to be preferred for the following reasons, apart from the question of cost:

In welding with the electric arc heat must of necessity be concentrated upon one point, viz.: that to which the temperature of the arc is imparted. In oxy-acetylene welding, on the other hand, the heat can be brought to bear at will on the surrounding material. The correct welding temperature can thus be gradually attained at any desired point. In electric welding any unsteadiness of the hand will at once strike the arc between the two carbon points, and will thus cause an addition of fused material to the bulk of metal where it is not required. In the oxy-acetylene process material can be gradually built up as desired exactly on the part to which the flame is being directed.

In electric welding the arc is formed at the expense of atmospheric oxygen, and this fact indicates that chemical changes of an oxidizing character must take place in the welded part. In oxy-acetylene welding the welded part is surrounded by a shield of hydrogen, which tends to isolate atmospheric oxygen from the part being welded.

In electric welding a fairly stout iron wire must of necessity be used to serve as a pole of the electric arc, whereas in oxy-acetylene welding thin wires can be employed, and these are found by experience to be most suitable for the work.

In electric welding the size of the drop of fused metal added in building up the weld is not within the control of the welder to anything like the extent it is in the case of the oxy-acetylene welder.

Finally—and this is perhaps the most important point of all—in electric welding the subsequent treatment of the welded place, such as gradual annealing of the area surrounding the weld, is impossible. In oxy-acetylene welding this can be done with ease and, as already pointed out, it is just this subsequent treatment of the welded part with a view to removing internal strains and depriving the weld of its hard and brittle character, which forms the special merit of oxy-acetylene welding in large and restrained structures, such as boiler flues and similar apparatus where homogenity of the metal is a matter of utmost importance.

As illustrating the relative efficiency of oxy-acetylene and electric welding, it is of interest here to quote tests published by Mr. Ruck-Keene, the principal engineer surveyor of Lloyds, in an instructive paper read by him before the members of the Institute of Marine Engineers on September 28, 1907. The material operated upon was in each case the same, and it is important to note that while in the case of electric welding the ultimate tensile strength is somewhat greater than that obtained by oxy-acetylene welding, the ductility of the metal in the latter case is considerably better. The tests are, however, of chief importance as indicating the value of annealing.

OXY-ACETYLENE WELDING

	Bre'dth	Thick-ness	Area	Tons Total	Tons per sq"	Extension in 4 Ins. per cent.
	Inches	Inches	Inches			
Not annealed.....	1.5	.62	.93	22.85	24.5	30 Solid Plate
Annealed............	1.5	.62	.93	22.35	24.0	36
						Extension in 8 Ins. per cent.
Not annealed.....	1.5	.62	.93	22 9	24.6	28 Broke away
Annealed............	1.5	.63	.945	22.1	23.3	29 from the weld.

COLD BENDS.

Not annealed...180°
Annealed...180°

ELECTRIC WELDING

	Bre'dth	Thick-ness	Area	Tons Total	Tons per sq"	Extension in 4 Ins. per cent.
	Inches					
Not annealed......	1.0	.56	.56	15.35	27.4	12 Broke
Annealed............	1.0	.55	.55	14.5	26.3	14 through weld.

COLD BENDS.

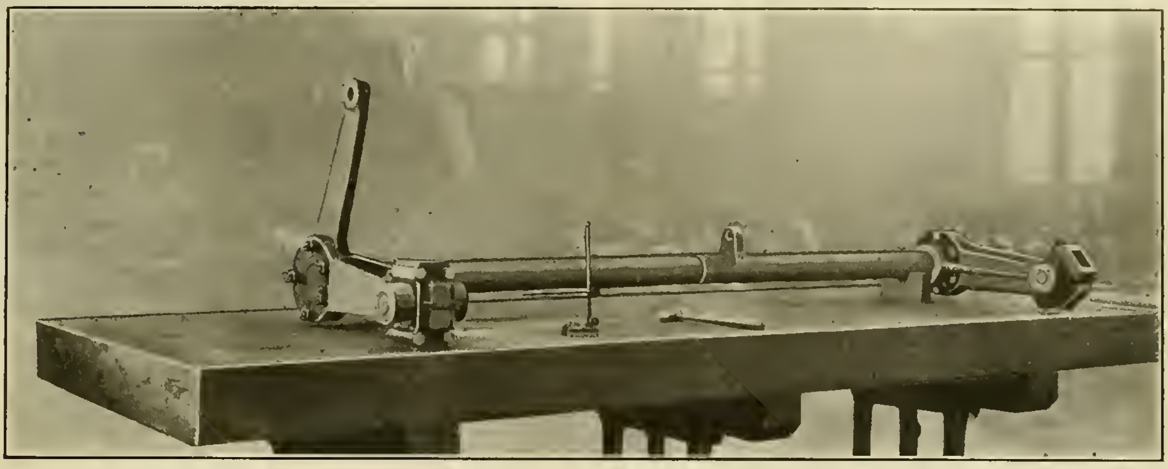
Not annealed (showed signs of fracture at weld)..........................58°
Annealed..100°

INCREASE IN MILEAGE DURING 1909.—During the past year 3,748 miles of railway, not including electric railway, have been built in this country. During the previous year 3,214 miles were built.

FACE PLATE FOR TESTING VALVE GEAR.

In order to be sure that the valve gear, which has undergone repairs and is ready to be applied to the locomotive, is properly aligned, a face plate of ample dimensions has been installed in the Collinwood shops of the Lake Shore & Michigan Southern Railway. This plate, mounted at a convenient height in the valve gear assembling section of the shop, is shown in the illustration and all parts of every valve gear, which require such testing, as for instance, the reverse shaft, rocker arms and links, are put upon it and tested for accuracy of alignment and dimension before being applied to any locomotive.

Experience with this arrangement soon proved its value, as it has been found almost impossible to previously locate with accuracy the arms of a reverse shaft which had undergone repairs, or of the trunnions of the link and other parts. Inaccuracy at these points not only often causes a great deal of trouble in properly setting the valves, if in fact they can be properly set at all, but it also tends to aggravate itself the longer the engine is in service and causes constant trouble with the valve setting and general operation of the locomotive.



FACE PLATE FOR TESTING VALVE GEAR—COLLINWOOD SHOPS.

The plate can of course be used for general work when not required for valve gear and on account of its size has proven to be a great convenience.

TUNGSTEN LAMPS ECONOMICAL.—One tungsten lamp will replace five 16 candle-power lamps, giving the same candle-power, 80, and save in one thousand hours' service 180 kw. hours. The list price is $1.00 for five 16 candle-power lamps, and $1.60 for the tungsten—a list difference of 60 cents or a net difference of 48 cents. If we divide the saving, 180 kw. hours, into this difference in cost, we can readily find out at what price per kw. hour it will qualify, thus: 48 ÷ 180 kw. hrs. = 0.26, or, say, ¼ cent per kw. hour. Above this rate the tungsten lamp begins to return a saving. If we have a rate at 10 cents per kw. hour, the one hundred and eighty hours' saving has a value of $18.00. With a 32 candle-power 40-watt tungsten costing $0.90, the saving over two 16 candle-power carbon lamps is 72 kw. hours, and the additional list cost is 63 cents, therefore the 40-watt tungsten lamp saves its additional cost at about 6/10 cent per kw. hour and above. It is clear, therefore, that these lamps will pay their cost several times over at ordinary central station rates, and they are very economical lamps to use. The life performance is very good. It gives a life averaging eight hundred hours or more, with practically undimmed candle-power. The deterioration is not over 10 per cent., and, owing to the high brilliancy, the change in candle-power is not noticeable, so that the life of the lamp is actually its total life. The blackening effect in 800 hours is practically nil.—*F. W. Willcox before The Engineers' Club of Philadelphia.*

LOCOMOTIVE TERMINALS.

A DISCUSSION OF THE ARRANGEMENT, DESIGN, CONSTRUCTION AND OPERATION OF LOCOMOTIVE TERMINAL FACILITIES TO OBTAIN THE GREATEST EFFICIENCY.

PART II.

Cinder Pits

Location.—The cinder pits, as mentioned in the discussion of the track arrangement, are customarily located on a direct line between the coal chute and turntable and as close to the table as possible. As it is sometimes necessary to raise the grade of the cinder pit in order to obtain good drainage the distance from a pit to the table in such a case should be great enough so that there will not be trouble with engines running away and getting into the turntable pit. On the Pennsylvania and a few other roads it is believed that fires can be more easily cleaned when the tender is empty and the delay at the coal chute is not long enough to cause any damage, so the cinder pits are located ahead of the coal chutes. Long experience has not developed any objections to this arrangement.

The best type of cinder pit depends upon the number of locomotives handled in 24 hours, the drainage facilities, the amount of ground area available and the climate. There are two general types, *i. e.,* hand operated and mechanical; the latter including arrangements whereby the cinders are discharged into buckets that are hoisted and dumped by different methods: the clam shell loader operated by a locomotive crane and the traveling conveyor. Each of these are in successful operation at various points in the country, but in the great majority of cases the hand operated cinder pit is employed and this in most cases will probably be found to be satisfactory. Special circumstances often make it impossible or inadvisable to use the hand operated cinder pit where the general features appear favorable to it, and hence like all other features in connection with the terminal the decision must rest upon the conditions at each individual point.

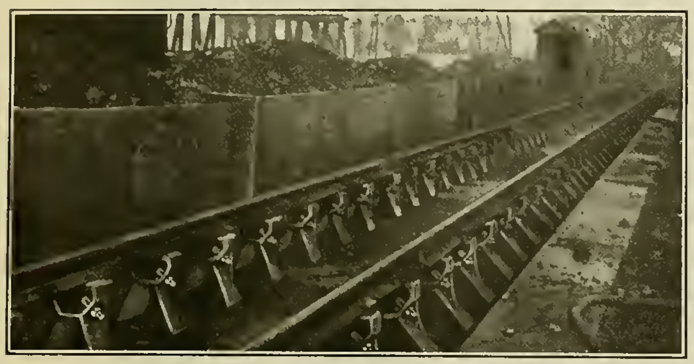
One of the most successful mechanically operated cinder pits is the type used on the Pennsylvania Railroad, where a narrow gauge track is set in the bottom of the pit and special buckets are carried by small cars, which run on this track. These are placed underneath the ash pan openings and after the fire is cleaned and the locomotive has moved off the pit they are pushed to a central point where the buckets are hoisted by an air cylinder on a transverse trolley, or in case of large terminals by a traveling crane and carried over the top of the cinder car setting on a track at grade, where they are dumped automatically. This arrangement was very fully illustrated and described on page 46 of the February, 1906, issue of this journal.

SYNOPSIS.

At points where a locomotive crane is used for coaling or other purposes in the vicinity, and it has not enough work to keep it busy all of the time a cinder pit arranged to be cleared by this method is found very economical and satisfactory. In such cases the part of the pit underneath the running track is sloped so that the cinders are discharged into a depressed basin that is usually partially filled with water and is of a size sufficient to hold a day's collection. The cinders are loaded by means of a clam shell or orange peel bucket operated by the crane, when it is available, upon cinder cars standing on a parallel track.

Size.—This factor is dependent upon the maximum number of locomotives which it is desirable to handle per hour and will usually be made larger than is required for average conditions. A long delay at the cinder pit is often responsible for a large part of the trouble with leaky boilers. The delay is, of course, dependent upon the number of locomotives that can be handled upon the pit at one time and the number of men provided for cleaning fires, rather than upon the speed at which the ashes and cinders can be cleaned from the pit. There are cases, of course, where with a hand operated cinder pit it would be impossible to keep all of the pit cleared for use, because of the steady and constant stream of locomotives passing over it. The condition, however, is not very general and following a rush of power over the pit, there will usually come slack times when it can be cleared and there will be as a general rule small probability of delay by the pit being filled with cinders. Hence where the layout, cost of ground, drainage and labor conditions will permit it will probably be found most satisfactory to install a hand operated cinder pit of sufficient length to accommodate a rush of locomotives, so that they can be passed on to the turntable with an average delay of not to exceed five minutes or at the rate of twelve per hour. Since it takes in most cases on an average of about thirty minutes to clean the fires and ash pans of large locomotives, this means that the pits must be of a size, and a sufficient number of men employed, to clean six locomotives simultaneously. The usual arrangement will be two parallel pits each holding three locomotives, or about 200 ft. in length. In addition to these there should be a small cinder pit suitable for one locomotive, or about 30 ft. in length, on each of the outgoing tracks.

Construction.—With the mechanically operated cinder pits, the construction, of course, is determined by the type and arrange-



GOOD DESIGN OF HAND OPERATED CINDER PIT.

ment. With the hand operated pit it is almost universally arranged to open on to a depressed track on which the cinder cars are stored. This construction has passed through several stages of evolution and is now almost standard. The inner rail is carried on a row of cast iron columns and the outer rail either by similar columns, or the wall of the pit. The floor of the pit is usually extended about 2 ft. beyond the rail to form a platform from which the men can shovel and also to prevent the cinders from dropping into the depressed section. The older arrangement was always to have the outer rail on the wall of the pit, but it has been found that with wide firebox locomotives it is preferable to carry it on a row of columns and set the wall back some distance, so that the water will not collect on the outside and the men can have a better footing for poking out the ashes in the pan. This also increases the storage capacity of the pit somewhat and is considered with favor where it has been used for some time. One of the illustrations shows a pit arranged in this manner and a drawing is also given showing the construction of the chair or column supporting the rails.

The depressed track should be set sufficiently deep to have the top of the cinder cars not more than 2 ft. above the level of the shoveling platform. This, of course, is sometimes impossible because of drainage conditions, but should be so arranged if conditions will permit. It is preferable, of course, to have the top of the cars come on a level with the platform, which will allow the use of aprons and prevent the dropping of cinders down into the pit. In a very few cases it has been possible to obtain the room and the proper drainage to so arrange a cinder pit that when the ash pans are emptied, cinders will slide down an incline and into the cars. This, of course, eliminates all shoveling and is an almost ideal condition, which unfortunately cannot be used at very many terminals, as usually, if the drainage is suitable, there is no room permitted for the long incline necessary to get the required depth.

While most of the modern pits are made with concrete walls and floors it has been found that this material in the latter place disintegrates after two or three years from the action of hot cinders and cold water. Recognizing this condition a committee of the Bridge and Building Association recommends that hard burnt brick or fire brick be used for the floors and shoveling platform of the pits. The brick when worn out can easily be renewed with comparatively slight expense and they stand the service better than a concrete floor.

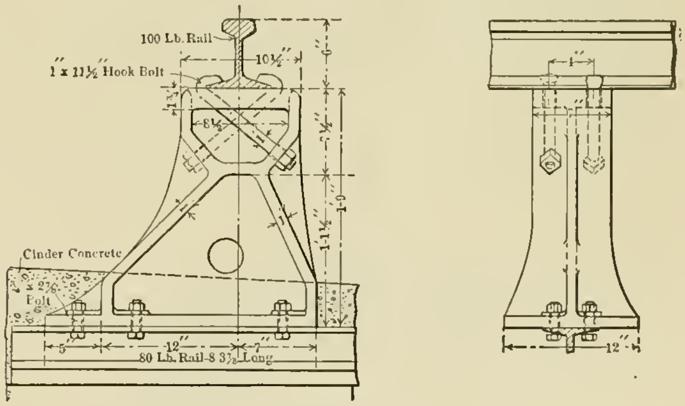
A guard on the inner surface of the shoveling platform, which will permit drainage but is high enough to keep the cinders from rolling off the edge, is advocated by many engine house foremen. This is also an advantage in that it gives something for the workmen to shovel against on that side of the platform.

Water Supply.—The water supply should be ample and convenient and it has been found that a 2-in. water main for each ash pit, having a hydrant about 25 ft. from each end of the pit and others not more than 50 ft. apart, spaced equally distant between these two, is very satisfactory. These hydrants should be so located and of a design that will not interfere with the workmen, and not be subject to injury by the tools that are thrown around. Numerous hydrants permit short sections of hose, which are economical in every way.

A high pressure steam line should also be provided at each ash pit with hydrants arranged the same as for the water. This main should be thoroughly insulated and the valves kept in good condition.

Shelter.—A tightly built shelter located in a convenient place and provided with heating facilities should in all cases be furnished in connection with the cinder pits in cold climates. The lockers and wash room for the cinder pit men should be in the same building and a desk provided for making out reports. The terminal telephone line should have a connection in this building.

Design of Locomotive.—In view of the fact that it is generally recognized that the cinder pit is in many ways one of the most important features of a satisfactory locomotive terminal, it is surprising how little attention was given up to very recent years to the design of the locomotive to facilitate the work at this point. The arrangement of the grates, their shaking connections and of the ash pans control the time that it takes to either clean or dump the fire and the ash pan. Everything that is to be operated by the men at this point should be of the strongest and most substantial construction in every particular. The engines are often frozen up and a coal pick is freely used to loosen up the ash pan slides or doors and the sides of the pan are pounded to loosen the frozen mass within. The time it takes to clean or dump a fire will be greatly facilitated if the grates are designed with this necessary operation in view. With a clinkering coal large dump grates at both ends of the firebox are of great assistance. Ash pan doors and operating gear should be

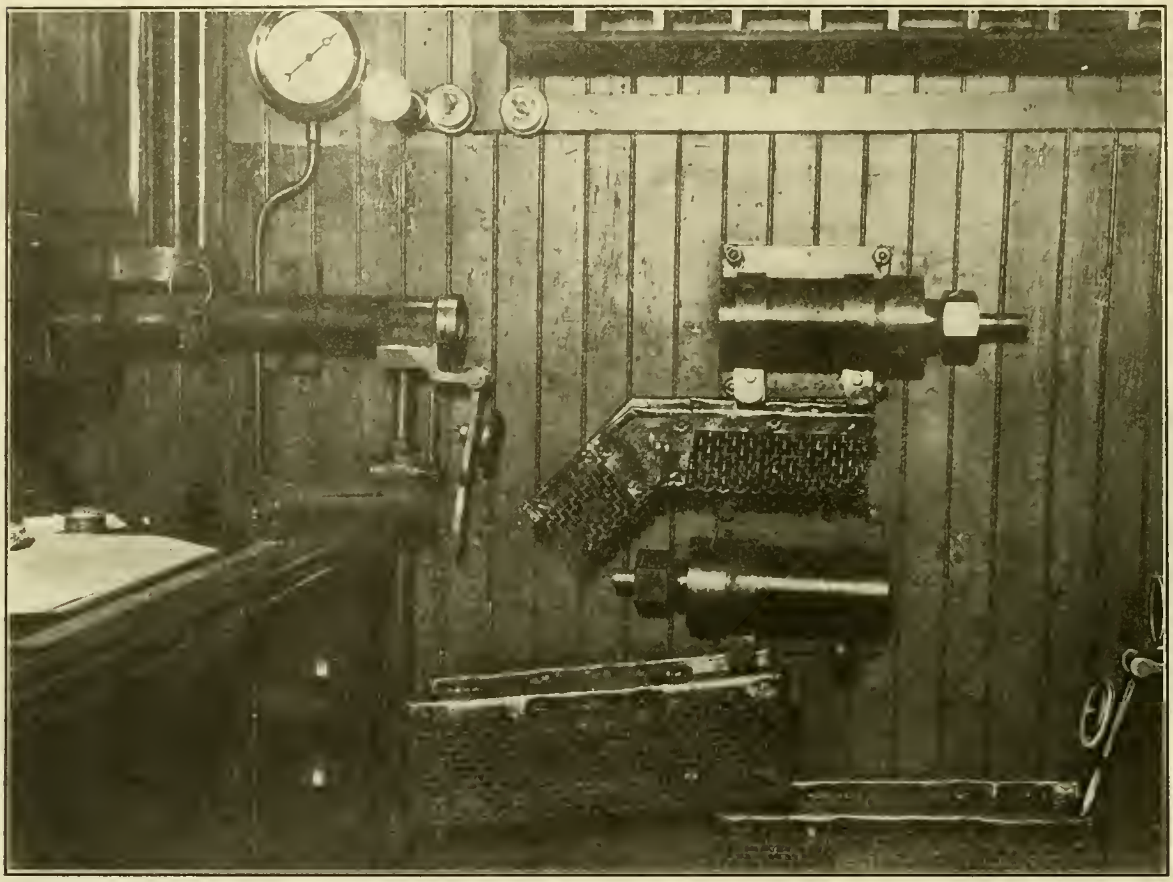


CAST IRON RAIL CHAIR FOR CINDER PITS.

designed with zero weather distinctly in mind. Shaker bars should be amply strong so that they will not be sprung and the operating levers should be so located as to have ample clearance when operated to extreme positions.

Inspection Pit

In order to be informed of the exact condition of an incoming locomotive at the earliest possible moment and thus be able to either immediately order it out again or make arrangements for quickly doing some heavy repairs, etc., it is advisable to inspect the locomotives the first thing after they reach the terminal and for this purpose at a number of the most recently constructed



END OF PNEUMATIC TUBE LINE FOR TRANSPORTING REPORTS FROM THE INSPECTION PIT. THIS VIEW SHOWS THE WORK CLERK'S DESK IN THE ENGINE HOUSE ON THE P. R. R. AT PITTSBURGH, WHERE TWO SEPARATE LINES TERMINATE.

engine houses an inspection pit is provided on the incoming tracks. It has been the custom to follow this practice at most of the division points on the Pennsylvania Railroad for a number of years and most satisfactory results are attained. At some points where severe winter weather is encountered it has been found necessary to house in the inspection pits, which can be done with little difficulty.

Inspecting pits should be located, preferably, at a point where the inspecting can be done before coal and water have been taken, so that in case it is found necessary to jack up the tender for repairs, orders may be issued not to take coal and water before going into the house. This location, however, is sometimes inconvenient or impossible and inspection pits are located just ahead of the cinder pit, so that a report of the repairs needed can be obtained without waiting until after the longer delay on the cinder pit.

Design.—Inspection pits are preferably constructed of concrete following very closely the design of engine house pits. They should be longer than the longest locomotive and be provided with a convenient and safe entrance and exit at one or both sides near the ends.

A shelter for the inspectors, fitted with lockers, wash-room and desks, as well as telephone, should be provided alongside of the pit.

Pneumatic Tube System.—At several points on the Pennsylvania Railroad a pneumatic tube connection is installed between the house at the inspection pit and the work clerk's office in the engine house by means of which the report of the inspectors can be put upon the work clerk's desk within a few seconds from the time they are made out and oftentimes they have reached this point before the engine has stopped at the coal chute. A device of this kind at a busy terminal cannot be praised too highly.

Several of the illustrations show part of this tube system, which consists simply of a 2-in. pipe laid in a box just below the surface of the ground, having all bends made with a large radius. The ends of this pipe are fitted with a hinged flap valve and just inside of the end is connected a small pipe from the compressed air system, having a plug cock in a convenient location. The air pressure is passed through a reducing valve and a pressure of but a few pounds is used. The fins inside the pipe are smoothed off so as not to form an obstruction and the carriers

CARRIERS FOR REPORTS OF INSPECTORS SENT TO THE ENGINE HOUSE THROUGH THE PNEUMATIC TUBE SYSTEM.

are made of pieces of old air brake hose, the two ends being plugged with wooden blocks and a leather cap secured to the outside, large enough to overlap the end of the hose. A couple of slits in the side form a self-closing flap, which will permit the

M. P. 62

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8½ x 5½

Pennsylvania Railroad Company.

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

Loco. No. ________ *Arrived at Terminal* ________

Train No. ________ *Division* ________ 19____ *Arrived at Ash Pit* ________

REPAIRS NEEDED	WORK DONE BY

Tools and Supplies ________
Condition of Gauge Cocks ________
" " Glass Water Gauge ________
" " Injector "R" ________
" " " "L" ________
Safety Valve Lifts at ________ lbs.
Safety Valve Seats at ________ lbs.
Reservoir Pressure ________ lbs.
Train Line Pressure ________ lbs.

________ *Engineer*

________ *Fireman*

Res. Pres. ________ } *Found.*
T. L. " ________

Res. Pres. ________ } *Corrected to*
T. L. " ________

________ *Inspector.*

________ *Foreman.*

Enginemen must report on this form at the end of their trip the condition of Locomotive, Gauge Cocks, Water Gauges, Injectors and Safety Valves; also any shortage in Tools and Supplies, Reservoir and Train Line Pressures. Air Brake Inspectors must report Reservoir and Train Line Pressures they find when pump is working to full capacity, make the necessary adjustments and state what these pressures are corrected to, signing name.

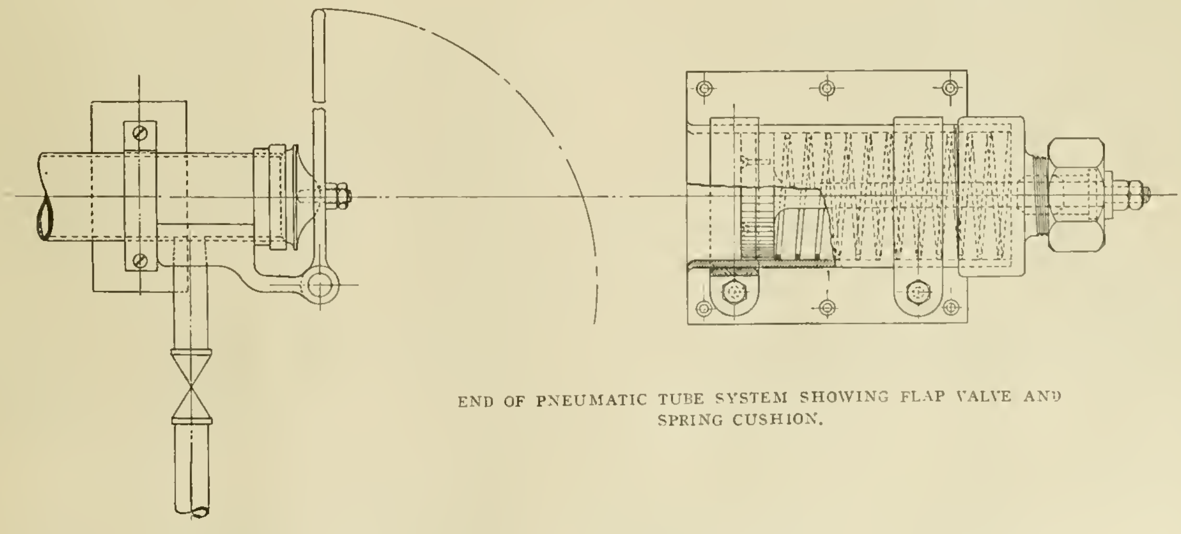
FORM USED BY ENGINEMAN AND INSPECTORS ON THE PENNSYLVANIA RAILROAD.

reports being stuck inside of the conveyor and not require any fastening.

The inspectors' reports are placed in one of these carriers, which is pushed into the end of the pipe beyond the entrance of the air supply, the hinged valve is held closed by hand, the air valve opened and the carrier will traverse several hundred feet in two or three seconds. On arriving at the opposite end it emerges from the pipe with considerable velocity and is stopped by a spring buffer, the construction of which is indicated in the illustration, and drops into a basket just below. When it reaches the work clerk's office he presses a button, which either rings a bell or lights a lamp at the opposite end to indicate that the carrier has arrived, upon which the air is turned off and the hinged valve allowed to drop. The same proceeding, of course, can be worked from either end and reports from the inspectors to the work clerk or vice versa are rapidly exchanged.

in most cases, the Pennsylvania Railroad at all of the larger division points has installed methods and developed an organization for doing the inspecting that is probably unexcelled in this country.

In the first place, as mentioned above, all locomotives are inspected as soon as they reach the terminal and before the engineer leaves. At a terminal handling from 100 to 150 engines per day a force of from four to six inspectors is constantly maintained and at larger points the number is increased. One of these men is paid a higher rate and is known as the "head engine inspector." The instructions giving the duties of this man are reproduced below. A second man is known as "engine inspector" and his duty covers practically all of the machinery and parts of the locomotive proper that are not covered by the head engine inspector. These duties are specified in his instructions also given below. The third man is "head air brake inspector."



END OF PNEUMATIC TUBE SYSTEM SHOWING FLAP VALVE AND SPRING CUSHION.

Instructions and Blanks.—While all of the better equipped roads fully realize the importance of very careful inspection of locomotives and perform this work with painstaking accuracy

The fourth is known as "air brake inspector" and the fifth inspector is called "steam heat inspector." Each one of these makes out a separate report on the official form (M. P. 62), a copy of which is shown in one of the illustrations. Each of these reports is signed and dispatched to the work clerk at the foreman's office. Three to five minutes is the time that is usually required to thoroughly inspect a large locomotive.

The inspectors carry small wrenches of several sizes and such loose nuts as are found and can be tightened without delay are secured by them and not reported.

The instructions issued by the master mechanic at Pittsburgh, covering the duties of these various inspectors, are as follows:

DUTIES OF HEAD ENGINE INSPECTOR.

Examine staybolt and boiler wash tags to ascertain if engine is due or overdue for staybolt test or boiler wash and keep a book record of same. When an engine is due for staybolt test or boiler wash, it will be his duty to mark it thus. "S. B." for staybolt test and "B. W." for boiler wash on steam chest, below where it has been placed.

Examine crown and side sheets for leaks, also note condition of flues to ascertain if stopped up or leaking.

Examine and try gauge cocks to see that they are in good condition, equipped with drip pipes and of the proper length.

Examine glass water gauge and blow it out according to instructions and see that same is in good condition, and determine location of Klinger water gauge glass to see if it is in line with first gauge cock.

Examine "First Aid Box," sprinkling hose, hold down scoop while man underneath gauges same, note condition of tank brake.

Examine fire door, latch and chain.

Examine condition of apron and hearth plate to ascertain if it is properly secured and in good condition.

He will note location of throttle gland to ascertain if packing will last until engine is due for boiler wash, see if hand railing is in good condition, also see that head lights are properly secured, front and back.

When an engine is due for boiler wash, he will note if throttle or any valves in cab need packing.

Examine around the outside of engine and tender, including trucks, wheels, draft timbers, draft rigging, brake hangers, frame, brake rubbers, clogs, etc.

Examine couplers, grab irons, foot boards, steps, safety appliances, to see that they are in good condition and where open links and "S" hooks are found to report the same to be removed and replaced with solid links, see that couplers are the proper height and in good condition, this to be determined by using gauge which is provided for that purpose, also open and close knuckle to ascertain if in good working order, noting condition of knuckle pin, and gauge knuckle with gauge which is provided for that purpose.

Examine all driving wheels, flanges, tires, etc.

Examine engine truck wheels, to ascertain any defects that can be discovered from the outside.

Examine main rods and brasses, side rods and brasses, knuckle joint pins, running board and brackets, branch pipes and clamps, expansion pads of fire box.

Examine boiler braces, guide yokes, crossheads and guides.

Examine crosshead keys and note if piston shows any sign of working in crosshead.

Examine oil pipes, cups and lids.

Examine engine frame for defects such as breaks, etc.

Examine cylinders and saddles in order to locate or find any defects such as breaks or cylinder working loose on frame.

Examine and report all missing or defective safety pins, which can be discovered from the outside.

Examine blow-off cocks and riggings.

Examine valve gear of engines that are equipped with outside gear, including reverse lever reach rod, tumbling shafts, links, etc.

Examine valve gear of engines that are equipped with inside gear, including reverse lever, reach rod, tumbling shaft, rocker boxes, etc.

Examine springs and riggings of engines and tenders.

Examine cylinder cock riggings.

Examine smoke box extensions for cracks, etc., hand hold plate on same, stack and steps.

Examine wheel covers, pilot bumpers and casting back of bumper between frame.

Examine and note condition of pilot to ascertain if it is the proper height from rail and in good condition.

Examine pilot steps, feed pipes, hose and connections, overflow pipes of injectors, cab brackets.

Examine drop grate levers and make a report of all levers found that are not equipped with a standard bolt and chain.

Note if any bearings are running hot on engine and tender.

Report all missing number plates and leaky wash-out plates or plugs.

Report any defects that might come under his notice other than mentioned above.

When any of the day or night force fail to report at the proper time, it will be his duty to retain an equal number of the retiring force until such time as they can be relieved.

It will be his duty to see that all other inspectors report for duty at the appointed time, that they properly perform their duties, that the inspection building and surroundings are kept in a clean condition, that all defects are reported on M. P. 62 blanks and sent to engine house promptly, that each inspector makes out an M. P. 62 report for each engine inspected, whether defects are found or not.

Inquire of engineman as to what work he has to report on M. P. 62 (Work Report) and designate on steam chest of engine where engine is to be placed.

Any neglect of duty shall be reported immediately to engine house office by him.

ENGINE INSPECTOR.

Examine engine truck, including wheels, frame, braces, king bolt, axle or axles, boxes (noting condition of sponging).

Examine machinery underneath, including the following parts, frame, stiffening pieces, etc., driving boxes (noting condition of sponging and hard grease), shoes, wedges, pedestal caps, axles, nuts on side rod collar bolts, to see that they are properly secured, engines that are equipped with the inside valve gear, including eccentrics, straps, rods and bolts, links, hangers, transmission bars, rocker boxes and bolts, lower rocker arms and bolts, oil pipes, cups, lids, etc., also note if nuts on bolts or eccentric cranks are properly secured, of engines equipped with the outside valve gear.

Examine draft between engine and tender, including draft iron, pins, safety bars and pins, castings on front end of tenders and all castings on rear end of engine frame.

Examine tail rails, spring chambers, and buffer casting.

Examine ash pan, dampers, and riggings, grates and riggings, etc.

Examine tender underneath, including the following parts:—trucks, center casting, wheels, frame, truck side bearings, etc.

Report all missing or defective safety pins underneath both engine and tender.

Report any leaks from tank cistern.

It will be his duty to report any defects discovered in the above mentioned, and make a report of anything else that might come under his notice, not stated above.

He will report all defects discovered on M. P. 62 (Work Reports), also turn in a work report for each engine inspected whether defects are discovered or not.

HEAD AIR BRAKE INSPECTOR.

Triple valves examined, cleaned and tagged every three (3) months and at such other times when found defective.

Report engines when due for special examination of air brake, which is at the time they are due for boiler wash.

Examine brake valve, air gauge, air pump and governors (noting if air pump is properly secured).

Examine condition of air pump inlet strainers (noting date on tag of air pump, reporting them washed after 30 days from date).

Examine air pressure, all air pipes (in cab and above running board), cut out cocks, main reservoirs (when located above running board) for leaks and see that same are properly secured.

Examine sanding device.

Examine steam dome, wash-out plugs or plates, check valve flange and whistle for leaks, and all valves in cab.

He must report all missing air brake tags.

Note last date (on tag) air gauge and steam gauges were tested, and report them tested after 30 days from date.

It will be his duty to report any defects discovered in the above mentioned, and make a report of anything else that might come under his notice, not stated above.

He will report all defects on M. P. 62 (Work Reports) and make out a work report for each engine inspected whether defects are discovered or not.

AIR BRAKE INSPECTOR.

Examine all air pipes, hose and connections that are located below running board for leaks and see that they are properly secured and in good condition.

Test air gauges by placing test gauge on train pipe at rear end of tender.

Test front end of train pipe and hose by closing hose at coupling and opening stop cock in train line pipe; main reservoir pressure to be turned on at this test.

Test air signal whistle, pipes, hose and connections by putting a coupler between air and signal hose, closing cut-off cock on signal line and turning main reservoir pressure on.

Examine fulcrum bracket and connections, tank brake and driver brake piston travel, cylinders and packing leather for leaks, with brakes applied.

Examine brake rigging of engine and tender, including brake bars, connections, rubbers, clogs, hangers, pins, etc., main air reservoir, when located below running board and see that same is properly secured.

Examine condition of air pump inlet strainers when located below running board.

Gauge scoop after it has been lowered by head engine inspector, note condition of scoop and rigging, also scoop heater hose and pipe.

Report all missing or defective safety pins.

Report any defect discovered in the above mentioned and make a report of anything else that might come under his notice, not stated above.

He will report all defects discovered on M. P. 62 (Work Report) and make out a work report for each engine inspected whether defects are discovered or not.

STEAM HEAT INSPECTORS.

Examine all valves in cab.

Examine all valves at rear of tank.

Examine all governors and operate to 100 lbs. pressure.

Examine all governors for leaks and defects.

Examine all joints in cab.

Examine all surface cocks or scoop heater valves.

Examine all joints between tank and engines.

Examine all drain cocks on couplings between tank and engine.
Examine all hangers and castings between tank and engine.
Examine all clamps between tank and engine.
Examine all hose on rear of tank and front of engine, putting on a dummy or blind coupling and having 120 lbs. of steam turned on.
Examine all safety chains on rear of tank and front of engine.
Examine all pipe coverings over steam heat line complete.
Examine all pipes and connections for leaks under engine.
Examine all pipes and connections on scoop heater line, joints and clamps complete.
Examine all pipes on front and rear ends for proper position to couple.
Examine both lines to see that they are open enough to overcome freezing.

Hostlers.—It is the custom at some points to require the hostlers to clean the fires, being assisted by the cinder pit men, as needed. While this custom has some advantages in the case of a very small terminal it is not advisable at a large or busy place and if followed means that there must be as many hostlers as there are locomotives arriving at any particular half or three-quarter of an hour period during the day, otherwise there will be serious delays. The best arrangement, if conditions will allow, is to have the engineer stay with the engine until it has arrived upon the cinder pit. This, however, is seldom possible or advisable and hostlers should bring the locomotive to the ash pit and in case there are other engines waiting he should leave it there and bring others up, putting those which have the fires cleaned into the engine house as soon as the cinder pit men are through with them. This shifting from one locomotive to another will be required only at certain periods of the day or possibly but a few days in the year and under normal conditions he will stay with the locomotive while the fire is being cleaned.

The instructions issued to the hostlers by the master mechanic of the Pennsylvania Railroad at Pittsburgh are very comprehensive and are given below:

INSTRUCTIONS TO HOSTLERS AND ENGINE PREPARERS.

It will be the duty of engine preparers in taking charge of an engine at any time to first try the gauge cocks, in order to ascertain the amount of water in the boiler; then examine the crown sheet, side sheets and flues for leaks, and if any crown bolts are found leaking to immediately report same.

It will be the duty of the engine preparer, before attempting to move an engine, to know that the wheels are not blocked, no parts of the engine are down, and that no one is working about or underneath the engine. Air pump should be started, and after having the required air pressure, cylinder cocks should be opened, hand brake of tender should be released and bell sounded so as to give warning.

Engine preparers when handling an engine must move very carefully and have engine under control at all times. They should not move or shift at any time more than two engines coupled together.

Engine preparers will note the condition of grates when cleaning or drawing fires, and if grates are defective, make a report of same; also the blower must be opened just enough to take away the smoke and dust, but it must not be turned on full.

Engine preparers must see that there are at least three (3) solid gauges of water in boiler, so that it will not be necessary to operate injectors while cleaning or drawing fires.

Injectors must not be operated while engine is on the turntable.

Fires must be banked near flue sheet, so as to prevent flues from leaking.

Engines must be placed in the engine house or storage yard after the fire has been cleaned, with sufficient steam pressure and water in boiler, and the fire in such a condition that the engine will not require any attention for at least one hour after.

Engine preparers, after placing an engine in the engine house or storage yard, must see that the engine is properly secured by having reverse lever in center of quadrant, throttle closed, hand brake of tender applied, and cylinder cocks opened.

Engine preparers or fire-up men when firing up an engine must see that the boiler has the required amount of water before firing up; also see that the throttle valve is closed, reverse lever in center of quadrant, hand brake of tender applied and cylinder cocks opened.

At points where track blocks are used in storage yard, it will be the duty of the engine preparer to place blocks under wheels.

Water Crane

There should be water cranes located to serve all outgoing and incoming tracks. The location on the outgoing track should be such that an engine taking water will not interfere with one behind stopping at the outgoing cinder pit. On the incoming tracks all possible locations seem to have been tried. It is the custom at some points to take water and coal at the same stop and in the case of the multiple track coal chutes if the two operations can be performed simultaneously this is a good location for the crane. However, this combination would not be possible with a side pocket coal chute. At other points water and sand are taken at the same stop and if the operations are performed simultaneously there is no objection to doing it, and probably in most cases this will possibly be found the best location for the water crane. In fact, water, coal and sand can all be taken at one stop, if the three operations are performed simultaneously, without objection and with considerable advantage. However, if they are performed independently and successively there is serious objection to doing it at one stop.

The 12-in. water crane is now almost standard and seems to be a very satisfactory size. It is recommended by the Maintenance of Way Association that in cases where the crane is not more than 100 ft. from the tank the pipe leading to it should be of the same size as the column. At a greater distance a size larger than the column is recommended. If these conditions are fulfilled a 12-in. crane will furnish the water rapidly enough for a 5,000 or 6,000-gallon tank. The crane should be capable of being swung both from the top of the tender and from the ground and the turning on and off of the water should be controlled from both points. The arm of the crane when parallel with the track should be locked in position.

The balanced self-draining and non-freezing valves which are now available for water cranes eliminate much of the difficulty that was formerly experienced.

Drainage around the water cranes will need careful attention since more or less coal is bound to fall off the tender at this point and will cause trouble in the drains unless proper provision is made. This is sometimes done by having a removable basket in the top of the sump, which is covered by the grating and a large part of the coal that gets through the grating can easily be removed.

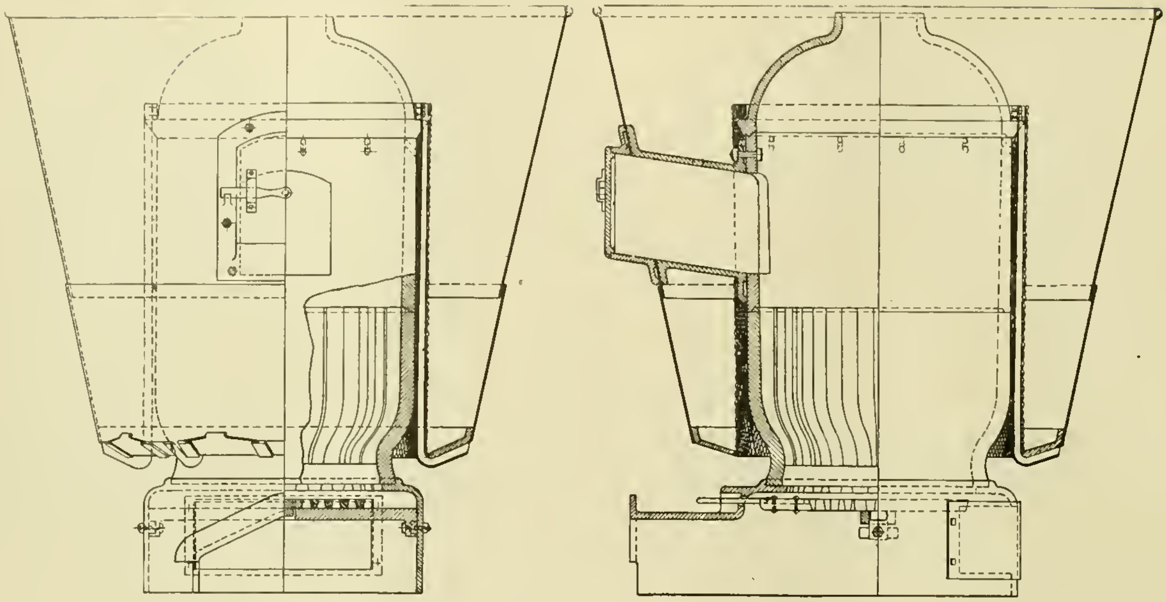
Sanding

It is almost the universal custom to dry the sand used by the locomotives at any terminal at the point where it is used, although the possibilities of having a central drying plant and shipping the dry sand is worthy of investigation and in some cases has been tried with great success.

Assuming, however, that sand is to be dried locally the construction at this point should be such that a minimum amount of manual handling will be required. Where a gravity coal chute is used it is probably best to place the sand house at the end of the chute and, if possible, ship the sand in bottom dumping cars, which can be placed over their hopper and discharged to a large wet sand bin below. This bin can be arranged to have a large storage capacity and will discharge direct to the drier without handling. At points where a trestle is not used, however, or where its location is inconvenient, if the terminal is large enough, a small, short wooden trestle can be built and the drier located below the ground level so that practically the same effect can be obtained. The advantage of such an arrangement will be greatly increased if self-dumping cars can be used, but where the sand has to be shoveled from the cars, or the terminal is small, there is no objection to the usual method of having the wet sand stored in a building alongside a spur track, provided its floor level is above the top of the sand drier and that the sand will not have to be lifted into the drier.

A number of types of driers have been suggested and used at various times, but the old cast-iron stove has maintained its place and is almost universally used. In his paper before the Railroad Club of Pittsburgh, William Elmer, master mechanic of the Pennsylvania Railroad, describes a stove and netting used on that road, that is excellent in every way. He said in part:

"It does not seem right to have the netting on the outside where the wet sand is and leave the dry sand packed around the hot stove with no way to get out but by forcing itself through layers of wet sand surrounding it. A very satisfactory arrangement is to have the netting close to the stove and separated from it by spacers, so that as fast as the sand is dried it is free to fall through. A row of holes drilled through the stove body near the upper part of this space will permit the steam to pass off through the smoke pipe. Stoves last much longer with this ar-



DESIGN OF SAND DRYING STOVE RECOMMENDED BY WILLIAM ELMER.

rangement, as the sand does not bake against the barrel and burn the section out. It has also been found very beneficial to put the stove sections on a boring mill and face the joints before erecting. This avoids the leakage of air through the joints as would be the case with rough castings. An opening at the bottom of the stove sufficiently large to take out the grate will prevent tearing down the whole arrangement when this repair must be made."

The common custom of lifting the dry sand by compressed air is most satisfactory and needs no comment other than the matter of the elbows or bends in the discharge pipe. These should be made of a very hard material and with thick walls on the outer curve. A carborundum protected metal, which it is claimed will resist the action of the sand blast, can now be obtained and would seem to be excellent material for this purpose.

The sand spout for filling the boxes should be flexible in every direction; a telescopic spout with ball joints is probably the best. The valve controlling the flow of the sand should be such that it will not be held from its seat by any small twig or other obstruction. A heavy cone-shaped valve seating against a hardened steel ring answers this purpose nicely and prevents the stream of sand from continuing to emerge from the spout after the valve has been closed. A further protection by means of a cap over the end of the spout will positively prevent any sand getting into the machinery.

Coaling Stations

There is probably a greater opportunity for improvement and saving in connection with the handling and use of fuel than in any other one thing on our railroads and, while this subject as a whole has no place in this discussion, the type of coaling station and its operation is largely dependent upon the method of keeping fuel records and of the activity of the department which has the cost of locomotive fuel in charge. In the first place, if the fuel record of the locomotives or of the engineers is carefully taken, and results are being obtained from its use, it is very essential that the amount of coal put on each tender be either weighed or measured with fair accuracy and the customary scheme of allowing a very low grade man to guess at the number of tons by the size of the pile should not be tolerated for a moment. The accurate weighing of the coal which goes on to the tender by the balancing of a scale beam is probably the most practical and this is being done with entire success at a number of coaling stations that have been in operation for several years. If the coal cannot be weighed the next best thing is calibrated pockets, which will give something approaching accuracy in the amount of coal taken by each locomotive. It has also been suggested, although so far as is known not yet tried, that the tenders be weighed before and after taking on coal. This suggestion, considered by some as being ideal in its results, presents a number of difficulties. A modification of this plan would be to equip the tender with a weighing hopper of some nature.

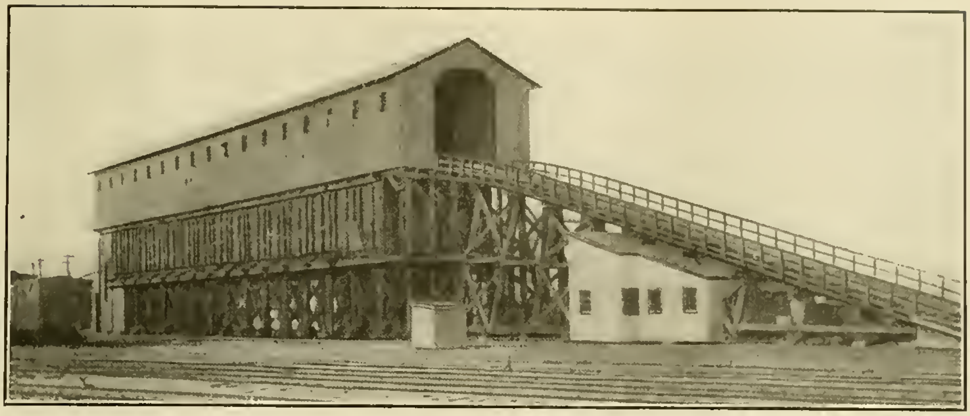
One or the other of these methods should be used at all new coaling stations, as without doubt it will not be very long before information as to the exact amount of coal used by each locomotive and each fireman will be required on practically all roads. The time when the coal chute man will not be asked to guess at the amount of coal put on is not very far in the future.

As was mentioned in connection with the discussion of the track arrangement, the shape of the plot, cost of the ground, labor conditions and steadiness of supply have a very decided influence on the type of coaling station that should be installed. There are four or five different types of mechanically operated plants now in operation, several of them numbering fifty or more different examples. There are also a number of what might be termed semi-mechanical plants in use, but by far the most numerous are the well-known trestle type, sometimes termed a gravity chute, where the cars are pushed up a long incline by a switch engine.

Each of these arrangements has points of advantage and each is in more or less successful service in a number of places. Where the ground area permits, it has been a general custom to install the trestle type of coal chute, the cars in some cases being drawn up by means of a cable. This type of plant as usually constructed, is cheaper to install, and for the first ten years at least, is cheaper to maintain than most of the strictly mechanical plants. When it is constructed of wood the fire risk is very decidedly increased, but on some roads, particularly the Pennsylvania. it has become the custom to use concrete as far as practical. The cost of operation of plants of this type is usually greater than the mechanical type, although where bottom dump cars are used there is no very decided difference. The cost of maintenance, as shown in the report of the Maintenance of Way Association, is considerably less, which, taken in connection with the decreased interest charge and the decreased cost of power, make them on the whole a less expensive chute.

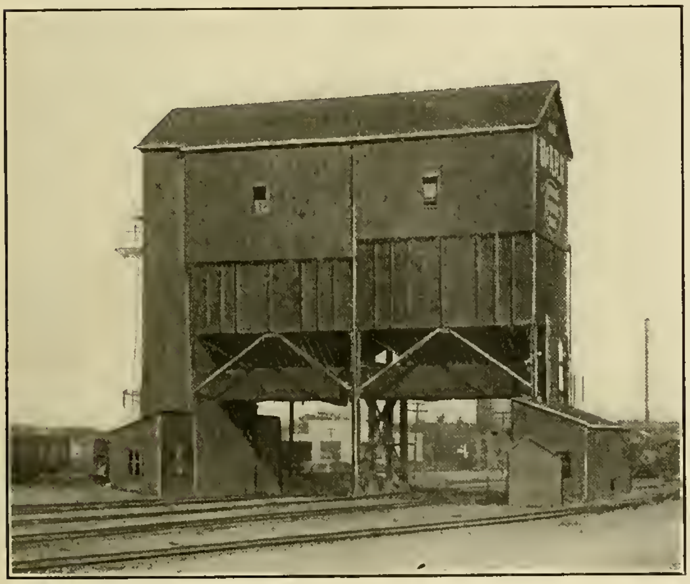
If in the case of a chute already installed it later becomes desirable to accurately weigh the amount of coal given each locomotive the side pocket gravity chute will be much more difficult to arrange. The nearest approach, to accuracy with this arrangement, without actual weighing, is the calibration of the different pockets by marks on the side, showing in some manner that will not easily be obliterated, the amount in the bin at each level, the scale being in single tons. In this way a fairly accurate record can be obtained.

With the trestle type of chute of a capacity which requires



TRESTLE TYPE COAL CHUTE ON THE B. & A. R. R. AT BEACON PARK. A "GOAT" DRAWN BY A CABLE OPERATES THE CARS ON THE INCLINE.

cars to be put up with comparative frequency a mechanical pulling device of some kind is very valuable. One of the illustrations shows the trestle coal chute at Beacon Park on the Boston & Albany Railroad, which has a very steep incline, the cars being pushed up by a "goat," which runs on a narrow gauge track between the standard gauge rails and is propelled by a heavy steel cable, the motive power being an electric winch located in a house underneath the incline. This "goat," which delivers its power against the face of the coupler, is used both for pushing up loaded cars and letting down empties. A pit is provided near the end of the incline into which it drops and allows the cars to pass over it. The grade of the storage tracks is so arranged that the loaded cars when once started will, by gravity, run down past the pit so that the "goat" can draw up behind them. The empty cars, on the contrary, are switched on to another line, which has a down grade away from the pit and will run on to the siding for empties with but little assistance. The mechanical part of this plant was installed by the Fairbanks, Morse & Co. of Chicago and has proven to be entirely satisfactory in service. This chute is also provided with a small electric capstan for moving cars on the two tracks of the level section on top of the trestle.

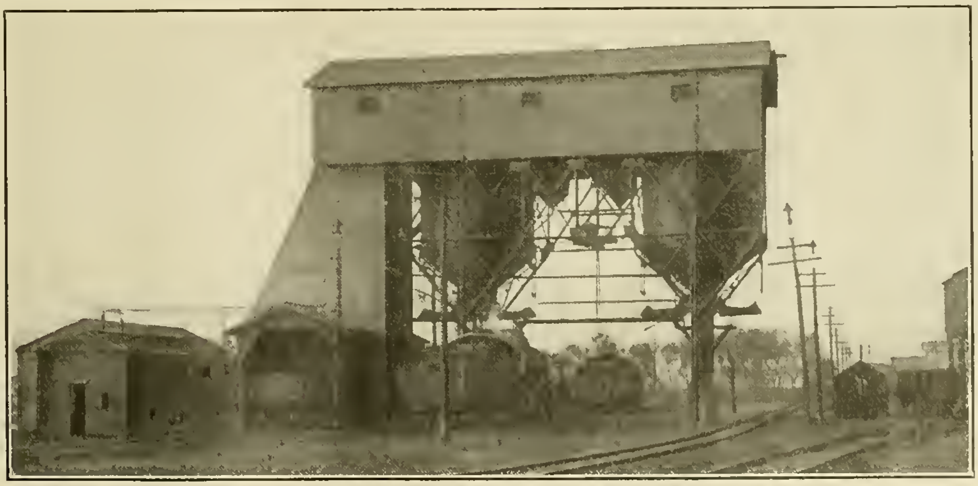


BALANCED ELEVATING BUCKET TYPE OF COALING STATION AT WEST SPRINGFIELD—B. & A. R. R.

Other schemes for drawing cars up the incline by means of a cable have also been used with more or less success. Where electric power is available an electric winch can be used for this purpose with considerable saving of ground area and eliminates the need of switch engines at times when they may not be available.

Mechanical coal plants in general have the following advantages: They permit the use of weighing hoppers, occupy decidedly less ground area, permit a more convenient track arrangement, greatly reduce the fire risk when, as is usual, they are constructed of steel, are of greater capacity and do not require the services of a switch engine. The disadvantages are the cost of maintenance, the greater possibility of interruption of service by accidents, greater breakage of the fuel and the increased first cost.

There are three different arrangements of mechanical plants in general use; one where the coal is carried up a long incline by means of a conveyor belt or a line of bucket conveyors; the second where it is elevated vertically and transported horizontally by a line of small buckets continuously operated, and the third where it is elevated and transported by two large buckets of two

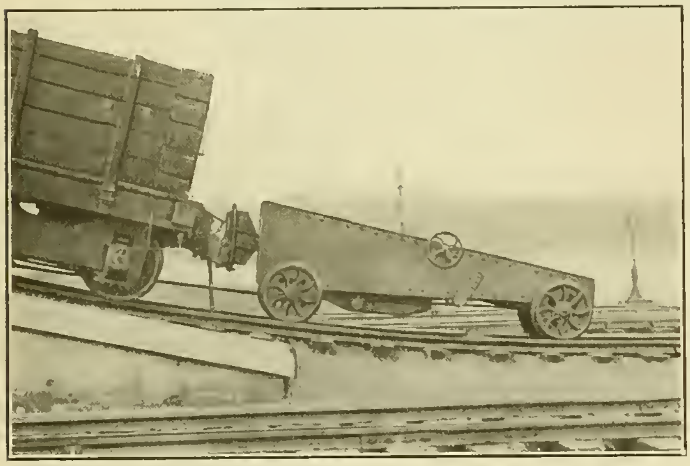


LINK BELT TYPE OF COALING STATION AT RENSSELAER—B. & A. R. R.

or more tons capacity, which are balanced one against the other and operate automatically.

An example of the first type using the conveyor buckets is in use at the East Buffalo engine house of the New York Central and was fully illustrated and described in the January, 1909, issue of this journal. An example of the second type as erected at the Boston & Albany at Rensselaer is shown in one of the illustrations and of the third type, which was installed at West Springfield on the Boston & Albany Railroad by Fairbanks, Morse & Co., is also shown. In each of these three examples the dry sand storage bins are part of the coal chute and sand is taken at the same time that the coaling is done.

Another method of coaling which has many advantages, particularly in cases where self-dumping cars are not regularly available for this service, is to use a locomotive crane with the clam shell bucket. The chief disadvantages of this arrangement is the delay in coaling and the impossibility of coaling more than one locomotive at a time unless more than one crane is employed, but since with suitable arrangements the coaling can be done while the fire is being cleaned the first difficulty can be overcome at many places. No elaborate structure is required, but on the other hand the storage capacity must be maintained in the cars. The depreciation on the car equipment is greater when the crane is used, but the coal can be put on the tender probably at a lower cost per ton than in any other method, everything being considered. In addition, the crane is valuable for other uses part of the time and in some cases it can be used to do all the coaling and to load the cinders as well. At points where a large storage supply is required at only certain periods of the year a locomotive crane is practically necessary and in some such cases the locomotives can be coaled directly from a stock pile and the cars released. The breakage of coal is probably less in this arrangement than in any other.



"GOAT" USED FOR OPERATING CARS ON THE INCLINE OF COAL CHUTE AT BEACON PARK.

In any type of mechanical plant, except the last mentioned, bottom-dumping cars are a necessity if the cost of operation is to be equal or less than that of the gravity chute. With this class of equipment in use, in both cases, the mechanical plant can be operated with fewer men.

Details.—An important detail in any type of coaling station is the arrangement of the chute and gate. There are several good designs of these features now in use, the best being a chute that is covered at the end and directs the stream of coal downward and an under cut type of gate that shuts off the flow from the bottom upward. The angle of the chute should be arranged for easy adjustment by the operator while the flow of coal is under way and the operating platform should be where a good view of the tank can be obtained without the necessity of standing on the tender, but should be easily reached from the top of the tender. Large hand wheels operating the lifting chains from both the chute and the gate by winding drums are probably the most satisfactory.

In the case of mechanical plants spanning the tracks the steel columns supporting the hoppers should be well protected against possibility of accident by a derailed locomotive.

A pipe line carrying high pressure steam should be carried to the coal chutes for the purpose of thawing out frozen cars. At some points an electric capstan is located for conveniently handling loaded and empty cars over the hopper of mechanically operated plants.

Oil Houses

Because of fire risk it is desirable to locate the oil house separate from the other buildings. This, however, is not convenient in all cases and where the proper attention is given to safety in the storing and delivering of oil it is customarily considered good practice to locate it in a fireproof section of another building, usually the store house. Because of the danger from fire this subject has been very thoroughly threshed out and it is now the universal custom to store the oil in tanks either underground or in a fireproof basement. These tanks are arranged to be filled by gravity from the tank car through a pipe from the track or, at small storage points, from barrels through openings in the floor above.

Probably the best method of delivering is by a self-measuring hand pump which accurately records the amount of oil drawn and automatically returns all drippings. Compressed air is sometimes used for this purpose, but it has the objection of causing quite serious deterioration in the oil and sometimes interferes with the delivery at the faucet.

The conclusions of the committee on buildings before the Maintenance of Way Association cover this subject very clearly and are given below:

"When practicable, oil houses should be isolated from the other buildings at a terminal.

"Oil houses should be fireproof and the storage should be either underground or in the basement.

"Oils that are stored in sufficient quantities should be delivered at the tanks in the house direct from tank cars. For oils that are stored only in small quantities provision should be made for delivery to storage tanks from barrels by pipes through the floor.

"The delivery system from the storage tanks to the faucets should be such that the oil can be delivered quickly and measured. The delivery should also be such that there will be a minimum of dripping at the faucet and that the drippings be drained back to the storage tanks."

(*To be continued.*)

Apprentices on the D., L. & W. R. R.—The Delaware, Lackawanna & Western Railroad has decided to open a school for apprentices in the Scranton machine shops and will in due time extend the system to the shops at Buffalo and other points. The work will be in charge of the railroad branch of the Young Men's Christian Association. The students will be paid their regular wages while attending the school. Spacious rooms have been set aside for instruction purposes at the shops. Robert B. Keller will be in charge as chief supervisor and J. M. Thomas as assistant.

Cost of Heating Electric Cars Electrically.—In this case the heaters consumed 48.5 per cent. of the power required for operation. This proportion of power taken by the two circuits, while it would vary somewhat on different roads, owing to differences in equipment, voltage, frequency of stops and number of passengers carried is a fair average for multiple-unit trains in city service. It is not contended that these figures are by any means absolute, but they are, nevertheless, the results of tests made in actual service, and as such afford a basis for estimating the additional load placed upon the power station equipment of any Northern road during the winter months. It is apparent that an increase of approximately 50 per cent. above their normal load thrust upon the feeder stations, especially upon days when snow and sleet are putting an extra burden upon them, calls for very heavy overload capacity, or for reserve units that will add a large item of cost to the substation equipment.—*Electric Railway Journal.*

CARS AND LOCOMOTIVES BUILT IN 1909.

The number of cars and locomotives built during the past year is but a little greater than the 1908 figures, in spite of the improvement in general business conditions during 1909. However, it has really been but a few months since the railways came into the market with substantial inquiries; and deliveries on orders placed at the beginning of this movement did not begin until this fall.

Returns from 14 locomotive builders in the United States and Canada (estimating the output of two small plants) show a total of 2,887 engines. Of the 2,653 built in the United States, 2,362 were for domestic use and 291 for export. These figures include 16 electric and 119 compound locomotives. The Canadian engines, 234, were all for domestic service.

Comparisons for the last 17 years are given in the following table:

Year.	No. built.	Year.	No. built.	Year.	No. built.
1893	2,011	1899	2,475	1905	*5,491
1894	695	1900	3,153	1906	*6,952
1895	1,101	1901	3,384	1907	*7,362
1896	1,175	1902	4,070	1908	*2,342
1897	1,251	1903	5,152	1909	*2,887
1898	1,875	1904	3,441		

*Canadian output.

During the past year 53 car building companies in the United States and Canada (output of one small plant estimated) built 96,419 cars, which is 23 per cent. more than the number built in 1908. These figures include subway and elevated cars, but not street railway and interurban cars. It must be remembered also that the output of railway companies' shops is not included. Of the cars built in the United States, 84,416 were freight cars for domestic service, 2,435 freight for export, 2,599 passenger cars for domestic service and 150 passenger for export. Of the freight cars 63,763 were of steel or had steel underframes; of the passenger cars, 1,650. Canada built 6,661 freight cars for domestic service, 58 freight for export, 99 passenger cars for domestic service, and one passenger car for export. In 1908, Canada built 8,598 freight cars and 79 passenger cars.

The following table shows the cars built during the past 11 years:

Year.	Freight.	Passenger.	Total.	Year.	Freight.	Passenger.	Total.
1899	119,886	1,305	121,191	1905	165,455	2,551	*168,006
1900	115,631	1,636	117,267	1906	240,503	3,167	*243,670
1901	136,950	2,055	139,005	1907	284,188	5,457	*289,645
1902	162,599	1,948	164,547	1908	76,555	1,716	*78,271
1903	153,195	2,007	155,202	1909	93,570	2,849	*96,419
1904	60,806	2,144	62,950				

* Includes Canadian output.

—*From the Railway Age Gazette.*

CONCILIATION BETWEEN RAILWAYS AND THE PUBLIC.—The Railway Business Association, 2 Rector street, New York City, has published a booklet containing the addresses delivered at the first annual dinner, given at the Waldorf-Astoria, on November 10, 1909. These include the introductory remarks by the toastmaster, George A. Post, president of the association, and the following toasts: "The Public and the Railroads," Hon. John C. Spooner; "The Nation's Farms and National Prosperity," William C. Brown; "The Railroads and Public Approval," Edward P. Ripley; "The Equipment Industries and Railroad Prosperity," W. H. Marshall; "Public Sentiment and Railroad Legislation," Hon. William P. Hepburn.

Proceedings of the International Railroad Master Blacksmiths' Association. Seventeenth Annual Convention, held at Niagara Falls, N. Y., August, 1909. Cloth, 190 pages, 6 by 9 in. Secretary, A. L. Woodworth, Lima, Ohio.

This association is doing splendid work. Among the subjects discussed at the convention were the following: Flue welding; tools and formers; high speed steel; piece work; locomotive frame making and repairing; case hardening; ideal blacksmith shop; spring making, repairing and tempering; best materials and methods of forging motion work, etc.

RAILWAY CLUBS.

Canadian Railway Club (Montreal).—The representatives of various car lighting companies will attend the meeting on February 1, and discuss the subject of car lighting. Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

New York Railroad Club.—At the meeting on Friday, February 18, F. A. Angier, of Galesburg, Ill., superintendent of timber preservation, C. B. & Q. R. R., will read a paper on "The Seasoning and Preservative Treatment of Wooden Cross Ties." Secretary, Harry D. Vought, 95 Liberty street, New York City.

Railroad Club of Pittsburgh.—At the meeting on February 25th, Harrington Emerson, of the Emerson Company, "Efficiency Engineers," New York City, will present a paper on the unit cost of railroad operation. Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

St. Louis Railway Club.—At the next meeting, Friday, February 11th, M. L. Byers, chief engineer of the Missouri Pacific Railway, will present a paper on "An Analysis of the Natural Relations Between the State and Industrial Corporations." Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Railway Club (Chicago, Ill.).—At the meeting in February, Tuesday, the 15th, a representative of the Allis-Chalmers Company will present a paper on gas engines. Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill.

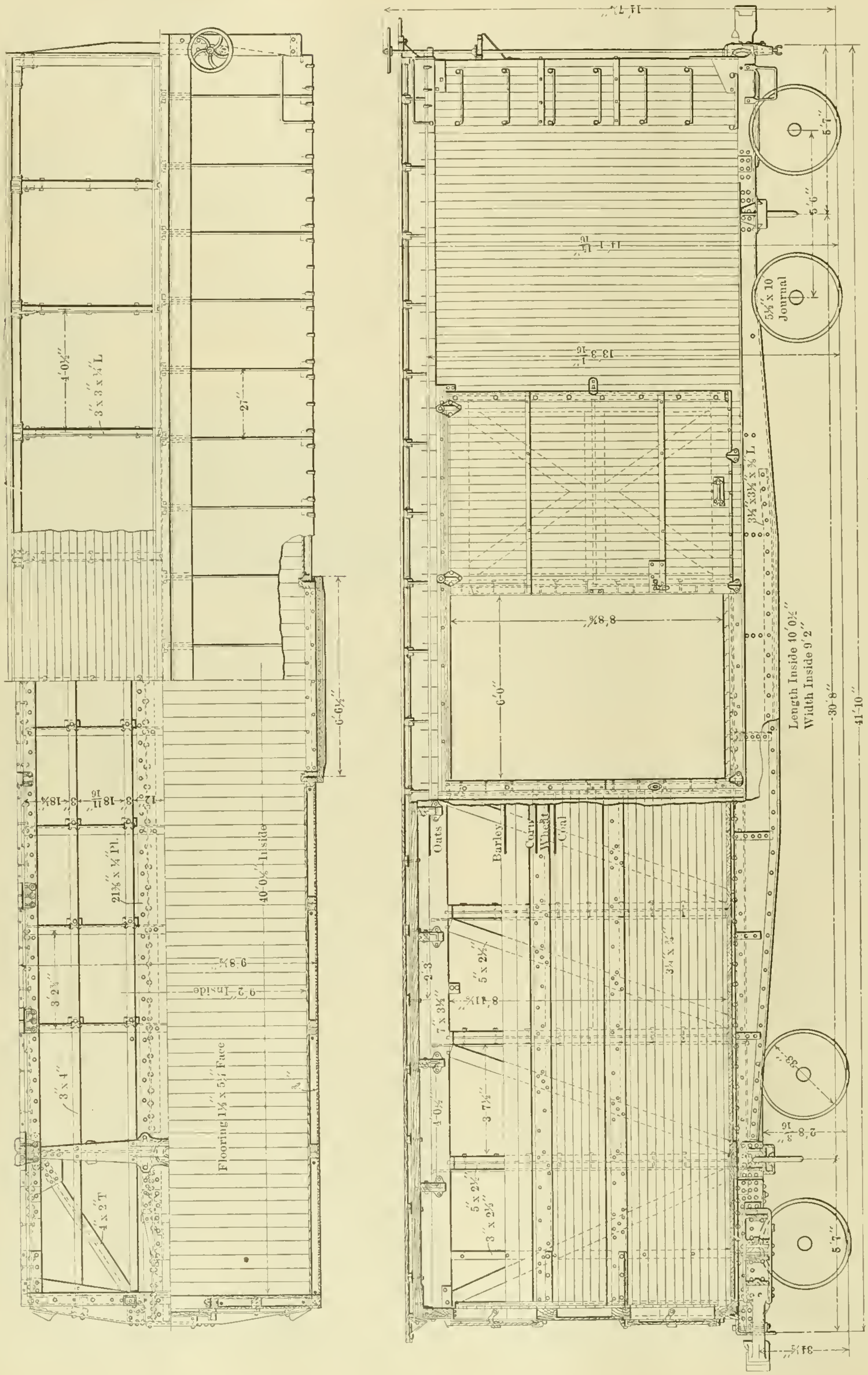
PENNSYLVANIA RAILROAD SCHOOL OF TELEGRAPHY.—Encouraged by the success attained by the graduates of its school of telegraphy at Bedford, Pa., the Pennsylvania Railroad Company has just completed the installation of additional machines for higher instruction. In addition, a library of text books on electricity in all of its branches has been opened for the benefit of the students of telegraphy. When the Bedford school was first opened, extensions of the company's own telegraph wires were run through the class room, to give the students an opportunity of handling practical railroad messages. In addition, there was installed a miniature railroad, equipped with block signals, for explaining the block signal system. The latest innovation to be placed in the school is an automatic sending machine, with a transmitter that can be set at any speed. This machine is used to teach the students to receive messages and as it transmits at a uniform speed, it is proving of great advantage. Since the Bedford School was opened in September, 1907, 234 students have been enrolled. Of this number 126 have been graduated and are now employed as telegraphers. All graduates are offered positions on the Pennsylvania Railroad.

TEMPERANCE IN SPEECH.—Talk about the homes made happy by abstinence from intoxicating drink! Why, it isn't a circumstance to the blessings that follow kindly words and acts. More hearts have been broken and greater property losses incurred as the result of ugly words than through inebriety. I propose to you as my closing thought and appeal, that here and now we launch a movement against intemperance in speech. Let those who are here, and the people everywhere, sign this pledge:

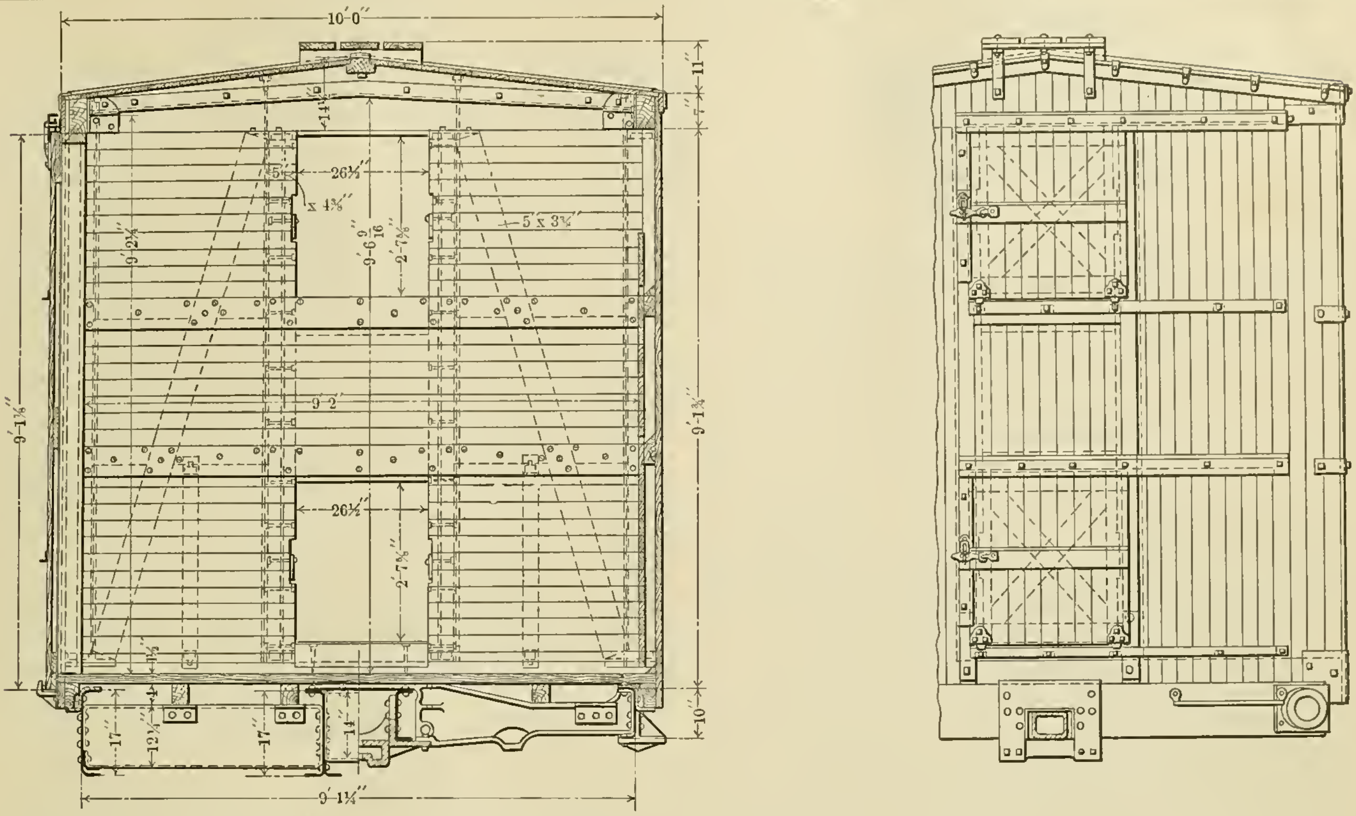
"I do solemnly promise that in the future I will abstain from the use of all intoxicating and inflammatory language."

Sign this pledge and stick to it, and the economic troubles that confront us to-day "will fold their tents like the Arabs and as silently steal away."—*George A. Post, President of the Railway Business Assn., before the Traffic Club of Pittsburgh.*

The number of passengers arriving in New York during the year 1909 by the principal trans-Atlantic steamship lines was 1,247,244, and the number leaving New York by the same lines was 482,756.



PLAN AND ELEVATION; COMMON STANDARD 50-TON BOX CAR FOR THE OREGON SHORT LINE.



Section Through Center of Car Section Through Bolster

CROSS SECTIONS AND END ELEVATION; COMMON STANDARD 50-TON BOX CAR FOR THE OREGON SHORT LINE.

FIFTY-TON BOX CAR WITH STEEL UNDERFRAME.

Oregon Short Line.

Five hundred Harriman Lines common standard fifty-ton box cars, with steel underframes, have recently been placed in service by the Oregon Short Line. This design, like those of the other common standard cars, is deserving of most careful attention, representing as it does the result of much investigation, discussion and study on the part of the Harriman Lines officials. Reference to the following table of general dimensions and data indicate that the car has an exceedingly large cubic capacity:

Length inside	40 ft. 0½ in.
Width inside	9 ft. 2 in.
Height, floor to carline	9 ft. 2½ in.
Cubic capacity	3,370 cu. ft.
Length over end sills	41 ft. 10 in.
Distance between truck centers	30 ft. 8 in.
Width over all	10 ft. 6 in.
Height from rail over running board	14 ft. 1 15/16 in.
Height from rail over brake mast	14 ft. 7¾ in.
Side door opening—clear	6 ft. by 8 ft. 8⅞ in.
Weight of each truck	8,016 lbs.
Weight of car complete	43,163 lbs.

The sills, both center and side, are of pressed steel ⅜ in. thick, 17 in. deep at the center and 10 in. deep at the bolster. They are reinforced beteen the bolsters by angles, as shown on the drawings. The center sills are covered at the top with a ¼ in. plate. The cross-bearers are pressed steel diaphragms. The pressed steel end sills are reinforced, as shown. The body bolster is of cast steel. The wooden stringers, 3x5 in., at the sides rest on Z bars riveted to the side sills; the intermediate stringers rest on the cross bearers.

The side posts consist of ½-in. iron plates sandwiched between two timbers, the three members being bolted together with ½-in. carriage bolts. The 13/16-in. pine roof is covered with Murphy galvanized iron roofing sheets, .022 in. thick. The standard trucks are used, the 33-in. wheels weighing 715 pounds each.

Water Power in U. S.—The theoretical power of the streams of the United States aggregates about 230,000,000 h.p., of which about 5,250,000 h.p. is now utilized.

ELECTRIFICATION OF STEAM ROADS IN CHICAGO.

Accepting the estimate of $400,000,000 as within the mark of reason, at 5 per cent. electrification would impose an annual fixed charge of $20,000,000 direct upon the railways running into Chicago. Superimposed on the charge for track elevation and attended as it would inevitably be by an increase of from $2,000,000 to $3,000,000 in taxes on the too palpable investment, the railways of Chicago would find themselves confronted by an annual fixed charge of $25,000,000 without the shadow of a guarantee that the change from steam to electricity would reduce the cost of operation or increase their efficiency.

And here comes in the question, who would pay the price of this uneconomic, unproductive experiment? Beyond question it would eventually fall upon the business community of Chicago, through increased passenger and freight tariffs. From these there could be no relief from the Interstate Commerce Commission because the Commission would be bound to find that electrification involved dissimilar and peculiar conditions and an expenditure which justified higher rates.

But here would come the pinch. Would and could the commerce and industry of Chicago bear the burden of increased railway charges imposed by electrification? The history of civilization says that it would not. Commerce and industry seek the fields of the least resistanse in dollars and cents paid out for power and transportation. Justice would demand that the community imposing this vast burden on the railways of Chicago should pay for it. And such is the immutable nature of the laws of trade that in the end Chicago would reimburse the railways or suffer the penalty of seeing its business pass to other centers of trade unembarrassed by unremunerative restrictions on transportation.—*Slason Thompson.*

Telegraph and Cable Statistics.—The total length of the telegraph and cable lines of the world is about 1,200,000 miles; the length of single wires about 4,000,000 miles; and the number of messages dispatched average about 1,250,000 per day.—*H. De B. Parsons.*

THE OLDEST RAILROAD JOURNAL IN THE WORLD
[Established 1832]

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Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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

When a Subscriber Changes his address *he should notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS

GOOD ORGANIZER.

The efficiency of a railroad shop was very low—so much so that the higher officials decided that some radical change must be made in order to get better results. A capable superintendent was obtained and told to go ahead and if necessary clean out the old organization. Some of the foremen who realized that they were "slated to go" became more or less antagonistic to the reforms inaugurated by the new man. To the surprise of these men and the management they were not discharged, but the superintendent started in a patient campaign to bring them to a realization of the fact that they were wrong and that their methods could be improved.

As a result in less than a year the capacity of the plant had increased almost 50 per cent. and not one of the foremen had left the organization. New men did not have to be imported who were unfamiliar with the conditions in the shop and the community and time was not lost in educating them for their positions. The foremen having the friendship and regard of the men were able, when they had their eyes opened, to do things which could not have been accomplished by a newcomer. This illustration simply serves to show that a real executive can bring about splendid results in an organization which is apparently made up of incapable men. The successful official must be able to inspire enthusiasm in and develop the men under him.

THE RAILROAD CLUBS.

If the railroad clubs in the States don't wake up and get a better class of papers for discussion at their meetings our Canadian friends will be in a class by themselves. The Canadian Railway Club at Montreal, especially, has done splendid work so far this season, having brought out each month, with marked regularity, a class of paper which it would be hard to excel. It is a long time since the grade of papers read before the railroad clubs of this country has been so low; good ones seem to be the exception rather than the rule. An indication of the difficulty of obtaining papers for the club meetings is shown by the fact that up to the time of our going to press only five of the clubs were able to furnish us with the subjects to be discussed at the February meeting. The work of the railroad clubs is so important that it is to be hoped that the membership at large will take a more active interest in assisting the officers in this matter. As a rule the officers are more than doing their duty in connection with the preparation of the programs, but their efforts are too often met with an indifferent response from the club members.

L. R. POMEROY ON ELECTRIFICATION.

Mr. Pomeroy's study of the problem of electrification of trunk lines is, we believe, one of the clearest, sanest and most convincing discussions of the subject that has as yet appeared. Having had exceptional opportunities for closely investigating the problem, both from the standpoint of the electrical engineer and from that of steam railroad mechanical and operating officials, and at the same time being possessed, to a marked degree, of the gift of eliminating unimportant facts and details, has enabled him to crystallize and clearly throw into relief the important advantages and disadvantages of both electric and steam railroad operation. If anything, the electric locomotive has been favored, but even at that its unfitness for use in trunk line service has been clearly demonstrated.

THE WEAK LINK.

If the locomotive terminal facilities are the critical feature of successful operation at times of congested traffic then coaling stations, cinder pits and accurate, rapid inspection are the most important minor cogs in the machine called railroading, and are worthy of careful, painstaking attention.

RAILROAD LEGISLATION

THE PRESIDENT'S CONFERENCE WITH RAILWAY OFFICIALS IN ITS TRUE LIGHT.

It would be difficult to exaggerate the importance to the railroads, the industries depending upon them and the country in general of the spirit in which the administration programme for amendments to the Interstate Commerce Act has been discussed by the president and his advisors on the one hand and the railway executives and their representatives on the other.

Newspaper accounts published following the interview of six railway presidents with President Taft and Attorney-General Wickersham on January 3 gave an erroneous impression. These accounts misrepresented both parties. The American Engineer has trustworthy information that the railway men, so far from presenting to the President a plea to be "let alone," or sulking, devoted their attention to broad, fair-minded discussion of changes which might be made in the text of the administration bill as it then stood. This was not with a view of thwarting the purposes of the President which he considers necessary to the public interest, but with a view to avoiding in the carrying out of those purposes needless injury to the railroads. The President met these advances in a similar spirit. When the bill was finally introduced on January 10 by Mr. Elkins in the Senate and Mr. Townsend in the House, it contained many important alterations inserted at the suggestion of the representatives of the carrying systems.

A significant confirmation of this account of the interview was given by President George A. Post of the Railway Business Association, which, of course, is energetic and resourceful in securing accurate information, in an address delivered on January 12 at a dinner of the New England Railroad Club in Boston.

"The railroad presidents," said Mr. Post, "were sought to be put in a bad light by the insinuation that they had been driven from the presidential presence empty handed and discomfited, with the inference that they had maintained merely an obstinate attitude of obstruction toward all the President's purposes and that he, in the interest of the people, had turned a deaf ear to everything and anything they had said. It was not true. This is not a proper treatment of such an important conference. It is not fair to the railroad managers; it is not fair to the people to be so misinformed. These railroad men are not enemies of our country; they are American citizens, men of ideas, men of action and men of honor.

"It would be strange, indeed, if the President of the United States could not learn from these men who have spent their lives in railroad service, some things of great importance and value to him as chief magistrate, which he did not know and could not learn except from such thoroughly informed men. It would be strange if railroad presidents with their views naturally colored by their intense desire to preserve adequate freedom of action in the administration of their properties, for the successful operation of which they are responsible, could not and did not learn from our wise, kindly, open-minded President, some things with regard to concessions necessary to make to public sentiment.

"The railways are not pursuing a policy of obstruction to the purposes of the Administration. It is to be hoped that this interview at the White House on January 3 will prove an augury of a new era, not only in dealing with the executive, but in the exchange of views before committees of Congress and in the preparation of state legislation."

It is needless to say that the method adopted by the present federal administration differs radically from that which has been pursued for years past by many executive and legislative officials in the nation and in the states. Moreover, a deep anxiety to be dead sure they are right before they proceed to the advocacy of new restrictions of railroads, is widely taking the place of a mastering desire to "do something" to the railroads and take chances as to its being right or wrong.

It would be grossly unfair, however, to those who in the past have been active in promoting regulatory measures not to say that one of the contributory causes of their state of mind was the attitude of the railway officials, which happily is passing away, as was illustrated by the tone in which the six railway presidents addressed the chief magistrate on January 3.

If, again, the railroad men in adopting toward the government an attitude of conciliation and of helpful suggestion have assured to themselves respectful consideration of their statements, and immunity, at least to a degree, from the violence which hitherto has characterized official feeling toward them, they have perhaps also placed themselves in position to enjoy another benefit of a more subtle kind, but it may be of some practical importance nevertheless. It will only be natural for those who are responsible for the successful management of these great properties to suffer very much less from fright over threats of legislation when they know that they are themselves taking a hand in the most honorable and above-board manner in the framing of the measures.

Any development which tends to minimize the apprehension of the railway officials as to the probably injurious effect of pending proposals is bound to be beneficent, not as tending to plunge the railways into extensions and improvements without adequate caution as to the possibility of future changes in conditions due to legislation, but as tending to give them reasonable reassurance. Upon such confidence among them and among those to whom they look for their security market depends in large measure whether the development of transportation facilities shall proceed in a stable and tranquil manner or by fits and starts, the ups involving over-extension in countless industries and the downs working proportionate havoc to all concerned.

If, through their organization formed for that purpose, the railway equipment and supply people have contributed in part to bringing about the more friendly relation now existing between the railway officials and those who regulate them, they are to be congratulated and they will be the first to say that there is glory enough for all.

WELFARE WORK ON THE CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway recently issued a profusely illustrated pamphlet describing the welfare work carried on by it. The following abstract covers this work with the exception of that part referring to the steamship department, Dominion Express Co., floral work and the hotel department.

The captains of industry have not been slow to find out that it pays to treat their army of workers fairly, and that to give to them the very best tools, the most favorable conditions for the performance of their duties, is an investment productive of good returns.

Welfare work may be said to consist of the efforts of the management on behalf of the employee, over and above the payment of wages, in making him more comfortable and contented with his work, and robbing old age of its terrors by means of a pension fund. The management frankly confesses that considerate treatment toward its employees is a paying business. The ne-improvements in equipment, and the enormous increase in traffic, have made railroading much more exacting in its requirements from the men who engage in it. This business, possibly more than any other, requires the clearest heads, the steadiest nerves and the strongest muscles, for the reputation of the road must always be safe-guarded. Therefore, the type of men operating the trains, building the cars and manning the ships is of the greatest interest and importance to the company. It is also important how its men spend their spare hours, when off duty, even though the company exercises no authority over them; it is willing to help to provide healthful, pleasant, wholesome recreation, and opportunities for mental and physical improvement.

Each year a larger amount of money is being devoted by the Canadian Pacific Railway Company to this special work for its employees. It has brought the men and the management into closer relationship. It has made the employees feel that the company takes a sympathetic interest in their welfare; that it is not merely trying to grind out the best years of their lives with exacting work, long hours and small pay without giving them anything to look forward to but retirement without compensation through disability or old age. This welfare or betterment work has done much to stamp out that spirit of discontent that once was prevalent among railway workers. It has generally raised the tone and character of the men, increasing their loyalty and efficiency, and helping them to realize that the success of the company that employs them means their own success, and that these both depend upon each worker doing well his own part.

Work for Apprentices.—The company has inaugurated at its Angus Works, Montreal, a new system for handling apprentices. This system, based on broad, common-sense lines, has become well established, and while probably much remains to be accomplished, the splendid progress made thus far and the strong organization which is being built up, promise well for the future. The management is not looking for immediate results, for it is far-sighted enough to look five, even ten, years ahead, feeling sure that its present efforts will be rewarded when that time elapses.

The young recruit, when seeking admission, has to satisfy the management as to his general intelligence and good health. When in the workshops, the future mechanic is put through a systematic and continuous training, which, upon completion of his apprenticeship, enables him to qualify for a mechanic's position, and then, by further instruction, advance to the highest position in the organization. Every facility is placed in the way of the ambitious and intelligent employee to receive instruction from qualified and experienced officials in shop and railroad work. The trend of this preliminary training has the tendency to create a desire in the aspiring employee. The training is progressive—starting first with educational instruction for the young employees, then advancing to shop and educational instruction for the apprentices, and finally the journeyman receives educational facilities which enable him to qualify for minor positions on the staff. The moral and physical side, as well as the mental, is covered by the training given.

The young employee, after he has received a training in reading and writing, elementary arithmetic, geography of the C. P. R. System, biographical sketches of past and present eminent Canadians, freehand drawing, punctuality and regularity, thoroughness, application and self-reliance, cleanliness, thrift and recreation, is put through courses of instruction in shop arithmetic, shop mechanics, shop practice and mechanical drawing, which enable him upon completion of his apprenticeship to qualify as a skilled mechanic. Then, if necessary, he may take advantage of the advanced classes in mechanics, electricity, locomotive and car construction, and workshop practice.

A very interesting feature of the training is the practical work of the boys in the workshops, which is carried on under the direction of skilled shop men who are termed shop instructors. These men are carefully selected, as they are held responsible for the moral as well as the practical training of the boys. The educational side of the training is carried on in a room set apart for the purpose, and well equipped with desks, tables, blackboards, cupboards, etc. The apprentices attend the instruction classes during working hours, and for the time thus spent are paid their regular wages. The instruction classes are under the charge of practical and technical trained men who are termed educational instructors.

In order to encourage the deserving apprentices, the company donates each year a scholarship to the ten best apprentices. These scholarships consist of complete courses in mechanical or electrical engineering, following the courses of the International Correspondence Schools, but taught by the company's own instructors. The company also awards two scholarships, tenable for four years at McGill University, Montreal, each year to sons of employees. The holders of these McGill University scholarships are employed by the company during vacation, and receive remuneration for their services.

A glance at the syllabus of the evening classes shows that the education given is upon very practical lines. Over 250 employees take advantage of these classes, the upkeep of which is chiefly borne by the men themselves but is assisted by the company and the educational department of the Province of Quebec. Last year several officials of the company awarded prizes to successful employees attending evening classes.

Instruction in Telegraphy and Shorthand.—The young clerks in the general and other offices at Montreal have equal opportunities with the apprentices in the shops for equipping themselves for their life work. Schools of telegraphy and shorthand have been in operation for some time, and the advantages they offer are being eagerly seized by a number of ambitions youths. There are two terms each year, and the classes meet three evenings a week, when the students of telegraphy are instructed in the mysteries of the key, taught how to dispatch trains, etc., etc. In the shorthand school Isaac Pitman's system is used. To ensure a regular attendance a monthly fee of $2.00 is charged each pupil, but this money is refunded in full at the end of the six months' term to the pupils who have attended 75 per cent. of the classes.

Instruction Cars for the Education of Employees.—The company provides instruction cars with competent men in charge to give instruction in the mechanism, operation and care of the Westinghouse air-brake, steam-heating and safety appliances. One of these cars is employed on Western Lines and another on Eastern Lines. The cars are equipped with stereopticon outfits and full sets of slides, so that illustrated lectures can be given to classes.

First Aid to the Injured.—For giving prompt assistance in case of accidents there is an organization called the Canadian Pacific Railway Center of the St. John Ambulance Association, which includes in its scope all employees of the Canadian Pacific Railway Company. Its object is not to rival, but to assist, the medical profession. First aid is quite distinct from the work of the surgeon, for where the work of the ambulance man ends that of the surgeon commences.

During the past three months first aid has been rendered to more than one hundred personal injuries at the Angus shops, including fractures to different parts of the body, dislocations, electric shocks, burns, scalds, severed arteries, injuries to the eye, and many more or less severe accidents. Many cases of blood poisoning have undoubtedly been prevented by having at immediate call men who can treat wounds by antiseptic dressings before bleeding has entirely stopped, as it is after bleeding has stopped that bacteria find their way into an open wound. In case of severed arteries there was an undoubted saving of life, as it is practically impossible for medical aid to reach the patient in time to save life in case of arterial bleeding. A great deal of suffering has been avoided by treating for shock immediately after the accident has occurred.

Quite a number of the men at the Angus shops have obtained certificates of qualification certifying to their ability to give first aid in any kind of accident likely to occur in connection with their occupation. Instruction in "First Aid" gives a man an intelligent conception of the nature of his injury, and by reason of the spreading of this important knowledge the old custom of applying cobwebs, tobacco juice, greasy waste and other filthy things to open wounds would not be allowed in any Canadian Pacific workshop. Ambulance instruction thus systematically organized means a saving of many lives, and much unnecessary suffering. It is the intention of the company to organize ambulance classes throughout its entire system.

The Railway Y. M. C. A.'s.—Another new building has recently been opened at Kenora, costing $30,000, to be devoted to special work for the railroad men. These buildings are given to the Y. M. C. A. to operate because of its unselfish purpose to be of service to railway men without financial gain. Boarding-houses had been erected by the company and given over to individuals, who made out of them what they could. This had not been altogether satisfactory, and now the company is trying an experiment with the Railway Department of the Y. M. C. A. The satisfactory working of one building at Revelstoke, B. C., during the past two years had induced the company to increase the number of points at which these buildings were established.

The general plan on which these buildings are operated is as follows:—The Railway Company makes a monthly appropriation sufficient to cover the salary of the secretary, in addition to providing light, heat, repairs, etc. The men pay a fee of $5, which covers use of baths, reading-room and general social privileges of the building. They pay $1.25 a week for a room and $4.50 a week for board. The operating of the building is in the hands of a local committee, composed for the most part of railway men.

Buildings have been opened at Schreiber and Chapleau, on the C. P. R. transcontinental line, in connection with the Railway Y. M. C. A. The buildings recently opened at these points each provide for forty-four men in the dormitories, and have a dining-room seating forty-eight, three bowling alleys in the basement, two billiard tables, reception room with large open fireplaces made of rough stones, bath-rooms, reading-rooms, smoking rooms, lockers, etc.

Comfortable Meals.—Napoleon said that an army travels on its stomach; a good comfortable meal for a workingman certainly means better work. Among the many special features at the mammoth Angus shops are the dining rooms for the men, which are unique in Canada. Good, wholesome, well-cooked food is served in warm, comfortable surroundings at very low prices. This service is possible because the company furnishes free buildings, light, etc. The system used is known as the "help yourself"—the men come in at one door, take a tray and pass along a counter, where they help themselves to what they desire as they pass to their seats. A ticket or check is placed by one of the attendants upon each tray, showing the price of the food they have selected. A full meal costs 19 cents, and an average meal about 15 cents. One thousand men can be comfortably seated at once in the two large dining-rooms.

Caring for the Men.—The company provides sleeping accommodation at every divisional point between the Atlantic and the Pacific, especially for the use of the engineers and firemen, for which no charge is made. These men, when at the end of their outward run, are sure of comfortable quarters in what are called "bunk houses." All of these kitchens have ranges attached by which the men can prepare their own meals, and at some of the more pretentious places, stewards are in charge, who furnish meals at nominal prices. Many of these "bunk houses" are supplied with railway papers, magazines and other literature. The sleeping and dining car department also provides sleeping accommodation for its porters at several points on the line.

For Mutual Protection.—As showing the hearty co-operation of the management and the men, the organization of a Safety League in Toronto—the first of its kind in the world—stands out as a splendid object lesson. The League consists of engineers, firemen, train, and yardmen, etc., and its purpose is the mutual protection of each other and the further safeguarding of the traveling public and the company's property by the strict enforcement of the standing rules and regulations. It is the duty of any member of this League who notices the violation of any rule by a brother employee to warn him of his neglect, and to report it to the League. The person named is compelled to accept the caution with thanks. The result is that the bulletins containing the violations bring to the attention of every member of the League the fact that certain rules are being disregarded, and this is having a marked effect in their close observance. As a matter of fact the infringements are of rules of minor importance, but the League's work is largely educational, and is proving beneficial to every one interested.

Pensions for Employees.—When the pension fund was created the following announcement was issued by the president of the Canadian Pacific Railway Co.:—

"The company feels that a time has arrived when some provision should be made for officers and permanent employees, who, after long years of faithful service, have reached an age when they are unequal to the further performance of their duties. With this object in view, the directors, with the approval of the shareholders, have, after a careful study of the question, determined upon a plan of superannuation, the particulars of which are set out in the accompanying rules and regulations.

"The system adopted calls for no contributions from the employees themselves.

"The company hopes, by thus voluntarily establishing a system under which a continued income will be assured to those who, after years of continuous service are, by age or infirmity, no longer able to perform their duties, and without which they might be left entirely without means of support, to build up amongst them a feeling of permanency in their employment an enlarged interest in the company's welfare, and a desire to remain in and to devote their best efforts and attention to the company's service."

The rules and regulations are very simple and easily understood. It is specified that all officers and employees who have attained the age of sixty-five years shall be retired, and such of said officers and employees who have been ten years or longer in the company's service shall be pensioned.

The pension allowance authorized shall be granted upon the following basis:—

"For each year of service an allowance of one per cent. of the average monthly pay received for the ten years preceding retirement, or preceding the date upon which the employee attained the age of sixty-five years, should he be retained in the service after such date; for example, an employee who has been in the service forty years, and received on an average for the last ten years sixty dollars per month, the pension allowance would be forty per cent. of sixty dollars, or twenty-four dollars per month." No pension allowance authorized, however, shall be less than twenty dollars per month.

In order that the direct personal relations between the company and its retired employees may be preserved, and that they may continue to enjoy the benefit of the pension system, no assignment of pensions will be permitted or recognized.

The acceptance of a pension allowance does not debar a retired employee from engaging in other business, but such retired employee cannot so engage in other business, nor re-enter the service of the company, except with the consent of the committee, without forfeiting his pension allowance. The number of persons over seventy years of age on the pension roll at January 1, 1909, was 105; between sixty and seventy years of age, 148; under sixty years of age, 23—total, 276 persons. The amount paid out for the year was $50,694.79, and the balance to the credit of the fund was $657,345.60.

Masks for Street Sweepers have been adopted by the Department of Street Cleaning, New York City, to prevent, as far as possible, the breathing of germ-laden dust. The mask is attached to the sweeper's hat and covers the lower part of his face, forming a screen over his mouth and nostrils. The commissioner of street cleaning is reported to have said that the sweepers have always been more subject to infectious diseases than any other men in the department, and that the breathing in of the dust raised by the brooms increases the danger of pulmonary diseases. In winter especially catarrhal troubles and influenza have been common.—*The Engineering Record.*

TEN-WHEEL PASSENGER LOCOMOTIVE WITH EMERSON SUPERHEATER—CHICAGO, GT. WESTERN RAILWAY.

TEN-WHEEL PASSENGER LOCOMOTIVE, WITH EMERSON SUPERHEATER, AND CONSOLIDATION LOCOMOTIVE.

CHICAGO, GREAT WESTERN RAILWAY.

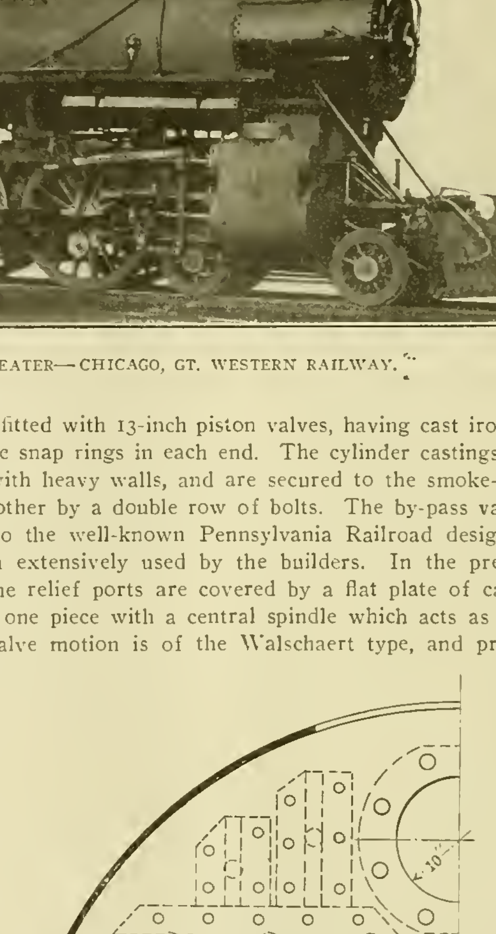
The Chicago, Great Western Railway has recently received twenty-four locomotives from the Baldwin Locomotive Works. Four of these are of the ten-wheel type for express passenger service; the remaining twenty are of the consolidation type for heavy freight service. Both designs follow the Harriman Lines standards in many respects, although important changes have been made in various details.

The passenger locomotives are of special interest, in that they are equipped with the Emerson type of fire-tube superheater. This device was first used on the Great Northern Railway, and the results so far have been reported as very satisfactory. In the Emerson type, the smoke-box headers approximate the usual steam pipes in form. Each header is divided into two compartments, one for saturated, and the other for superheated steam. The large boiler tubes, which accommodate the superheater elements, are placed immediately back of their corresponding headers, instead of being grouped in the upper part of the boiler barrel, as is usually the case with fire-tube superheaters. In the Chicago, Great Western locomotives the headers are straight, and stand vertically. The superheater elements on each side are placed in 12 tubes, arranged in two vertical rows of six tubes each. The superheated steam section of the header is centrally located between the two divisions of the saturated steam section, the latter being divided at the top. At the lower end, the superheated sections of the two headers are connected by an equalizing pipe. The superheater elements are composed of steel tubes having an internal diameter of 1 in. These tubes are expanded into the headers and are arranged with a double loop in each large boiler tube. The loops are connected by cast steel return bends. A plug is screwed into the front of the header opposite each tube opening. Application has been made for a patent covering this design.

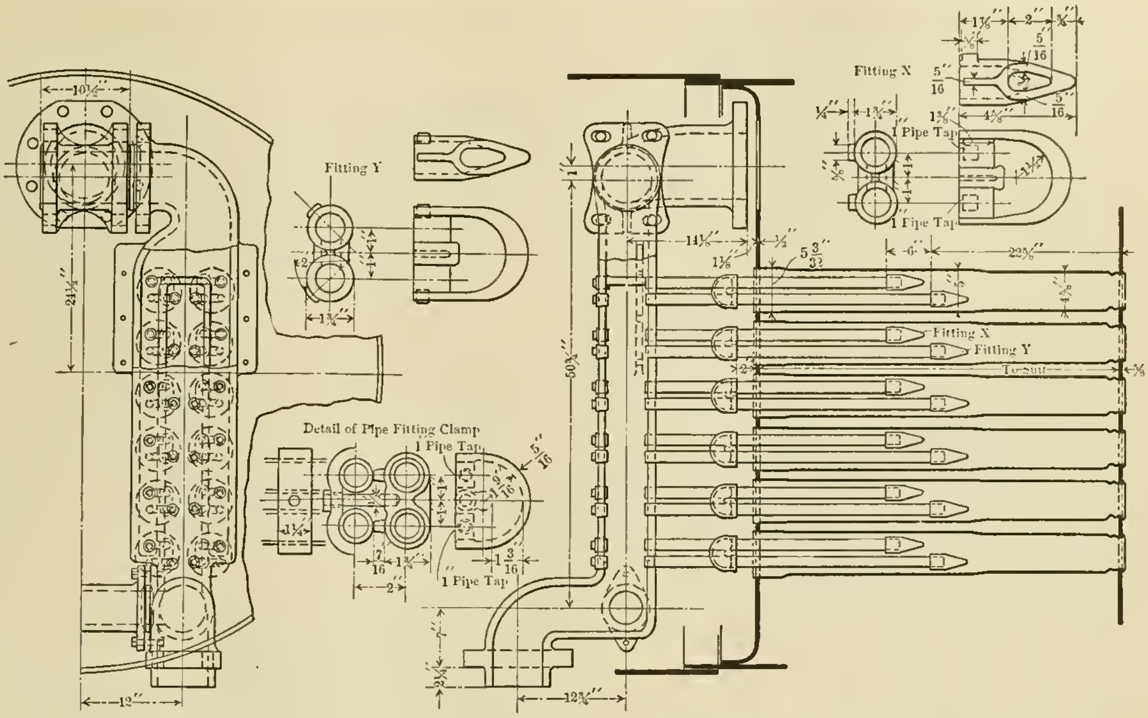
The smoke-box contains a single high nozzle, and the stack is tapered, with a minimum internal diameter of 20 inches. An adjustable petticoat pipe extends downward from the stack base, and an adjustable diaphragm plate is located in front of the nozzle. The boiler has a straight top and a wide firebox. The mud ring is 5 inches in width all around, so that liberal water spaces are provided. The crown sheet is flat, and is stayed by inverted T-bars hung on expansion links. The longitudinal barrel seams are butt-jointed, with "diamond" welt strips.

The safety valves are set at 150 pounds, and with cylinders 26 x 28 inches and driving wheels 73 inches in diameter, the resulting tractive force developed is 33,050 pounds. The cylinders are fitted with 13-inch piston valves, having cast iron bodies and three snap rings in each end. The cylinder castings are designed with heavy walls, and are secured to the smoke-box and to each other by a double row of bolts. The by-pass valves are similar to the well-known Pennsylvania Railroad design which has been extensively used by the builders. In the present instance the relief ports are covered by a flat plate of cast steel, made in one piece with a central spindle which acts as a guide.

The valve motion is of the Walschaert type, and presents a simple arrangement of this form of gear. The link is mounted in a specially designed steel casting, which also serves as a support for the reverse shaft bearings. This casting is bolted at the front to the guide yoke, and at the back to a crosstie located between the first and second pairs of driving wheels. The combination lever is pinned directly to the valve rod, and the latter



SHOWING ARRANGEMENT OF SUPERHEATER TUBES.



EMERSON SUPERHEATER AS APPLIED TO CHICAGO, GREAT WESTERN 4-6-0 LOCOMOTIVE.

is supported by a suitable bracket mounted on the upper guide bar.

The consolidation locomotives use saturated steam at a pressure of 200 pounds. With 24" x 30" cylinders, and driving wheels 63 inches in diameter, the resulting tractive force is 46,600 pounds. The weight available for adhesion is thus utilized to the best possible advantage.

The steam distribution in these locomotives is controlled by balanced slide valves. The cylinders are arranged with their center lines coincident with the steam chest centers. Each combination lever is pinned to a long crosshead sliding in two brackets which are bolted to the top guide bar. This crosshead carries a lug to which the valve rod is secured. In this way the motion is transferred from the plane of the link to that of the steam chest center, without the use of a rocker. The boilers of these engines are straight top, with crown-bar stays, and as far as construction is concerned, follow Harriman Lines practice closely.

The tenders of both classes are similar, and are mounted on arch-bar trucks having steel bolsters and "Standard" rolled steel wheels. The longitudinal sills are 12-inch steel channels.

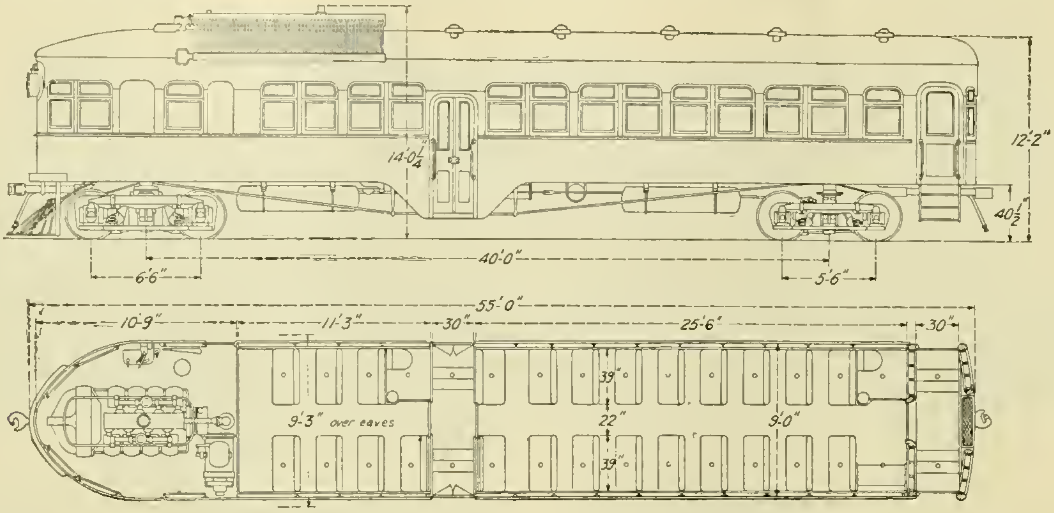
The principal dimensions of both classes of locomotives are as follows:

	Ten-Wheel.	Consolidation.
GENERAL DATA.		
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Service	Passenger	Freight.
Fuel	Soft coal	Soft coal.
Tractive effort	33,050 lbs.	46,600 lbs.
Weight in working order	198,050 lbs.	216,000 lbs.
Weight on drivers	144,950 lbs.	187,000 lbs.
Weight on leading truck	53,100 lbs.	29,000 lbs.
Weight of eng. and tender in working order	343,000 lbs.	360,000 lbs.
Wheel base, driving	15 ft.	17 ft.
Wheel base, total	27 ft. 1 in.	25 ft. 8 in.
Wheel base, engine and tender	57 ft. 9½ in.	58 ft. 6 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.38	4.01
Total weight ÷ tractive effort	5.99	4.63
Tractive effort × diam. drivers ÷ heating surface	1024	796
Tractive effort × diam. drivers ÷ equiv. htg. surface*	792	—
Total heating surface ÷ grate area	47.5	74.3
Equiv. heating surface* ÷ grate area	61.5	—
Tube heating surface ÷ firebox heating surface	14.8	20.5
Weight on drivers ÷ total heating surface	61.5	50.7
Weight on drivers ÷ equiv. heating surface*	47.6	—
Total weight ÷ total heating surface	81.1	58.6
Total weight ÷ equiv heating surface	64.0	—
Volume both cylinders	17.2 cu. ft.	15.6
Total heating surface ÷ vol. cylinders	136.9	236.2
Superheater surface ÷ vol. cylinders	26.7	—
Grate area ÷ vol. cylinders	2.88	3.18
Equiv. heating surface* ÷ vol. cylinders	177.0	—
CYLINDERS.		
Diameter and stroke	26 x 28 in.	24 x 30 in.
VALVES.		
Kind	Bal. piston	Balanced slide.
WHEELS.		
Driving, diameter over tires	73 in.	63 in.
Driving, thickness of tires	3½ in.	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.	10½ x 12 in.
Driving journals, others, diameter and length	9 x 12 in.	9 x 12 in.
Engine truck wheels, diameter	33½ in.	33 in.
Engine truck journals	6 x 10 in.	6 x 10 in.
BOILER.		
Style	Straight	Straight.
Working pressure	150 lbs.	200 lbs.
Outside diameter of first ring	70 in.	80 in.
Firebox, length and width	107 15/16 x 66⅛ in.	108 1/16 x 66⅛
Firebox plates, thickness	S. & B. 5/16, C. ⅜, T. ⅝ in.	5/16, ⅜, ½ in.
Firebox, water space	5 in.	5 in.
Tubes, number and outside diameter	24, 5 in.—203, 2 in.	413, 2 in.
Tubes, length	16 ft.	16 ft. 4 in.
Heating surface, tubes	2,206 sq. ft.	3,514 sq. ft.
Heating surface, firebox	149 sq. ft.	171 sq. ft.
Heating surface, total	2,355 sq. ft.	3,685 sq. ft.
Superheater beating surface	460 sq. ft.	—
Grate area	49.5 sq. ft.	49.6 sq. ft.
TENDER.		
Wheels, diameter	36 in.	33 in.
Journals, diameter and length	5½ x 10 in.	5½ x 10 in.
Water capacity	8,000 gals.	8,000 gals.
Coal capacity	11 tons.	11 tons.

* Equivalent heating surface equals evaporating heating surface (2,355 sq. ft.) + 1.5 times the superheater heating surface (460 sq. ft.) = 3,045 sq. ft.

Oil Allowance and Coal Consumption.—It has been the fashion of many roads for a number of years past to economize on the oil supply for locomotives to such an extent as to create more friction between moving surfaces in contact than there would be if proper amount of lubricants were used, also cutting frictional surfaces. This has resulted in locomotives burning more coal than they would otherwise, and lying down with their tonnage rating at times, when, if properly lubricated, they would have handled it. This is a case of spending dollars in trying to save cents. The matter of oil allowance should be left entirely to a practical man who is directly in charge of men and engines, to be handled by him regardless of the prevailing fashion.—*C. F. Smith, St. Louis Railroad Club.*

Relighting Arc Lamps.—Arc lamps should not be relighted immediately after they have been extinguished, unless it is absolutely necessary; an explosive mixture often exists in the globe a few moments after the light is extinguished, due to the mixture of gas and air. The writer has noted several instances in which every inner globe on the circuit has been shattered from this cause.—*R. H. Fenkhausen in Power and The Engineer.*



PLAN AND ELEVATION OF MOTOR CAR FOR SOUTHERN RAILWAY.

GAS-ELECTRIC MOTOR CAR.

SOUTHERN RAILWAY.

A brief description of the gas-electric motor cars recently purchased by the Southern Railway Company from the General Electric Company, and now under construction, may prove of interest to the many steam railroads which operate similar service. These cars have been designed with special reference to traffic conditions in the south. The car is divided by a center entrance. The seating capacity forward of this is 14, and to the rear is 38, making a total of 52. A rear entrance is also provided, thus completely dividing the forward and rear passenger compartments.

The car body is 55 ft. long over bumpers; of this space the engine compartment will take up 10 ft. 9 in., leaving the balance for passengers and platforms. It will have a steel frame and will be sheathed with steel plates, the interior trim being of mahogany. The truck under the engine compartment will have a wheel base of 6 ft. 6 in., and will be equipped with M. C. B. 33-in. steel wheels. On each axle will be mounted a standard 100 h.p. 600-volt box frame, commutating pole, railway motor, type GE-205, thus giving the car a motor capacity of 200 h.p. The rear truck will have a wheel base of 5 ft. 6 in.

In the engine compartment will be a direct driven gas engine generator set, the engine being of the 8-cylinder "V" type, each cylinder being 8 in. in diameter and having an 8-in. stroke. Direct coupled to the engine will be an 8-pole 600-volt generator provided with commutating poles. This set will be mounted on a cast iron base, and all parts will be above the floor line and readily accessible. Current from the generator will be supplied to the motors through a controller, the function of which is to place the motors progressively in series and parallel, and to vary the resistance in the shunt field of the generator by means of numerous steps, thereby varying the impressed voltage on the motors. The engine ignition is furnished by a low tension magneto and magnetic spark plugs. The carburetor is of the overflow type, and is hot water jacketed. Compressed air is used for starting the engine, this being supplied to the several cylinders in succession through a distributing valve. Compressed air is supplied from a pump direct driven by the main crank shaft. A small auxiliary gas-engine will drive an auxiliary pump to supply compressed air to the main reservoirs when necessary. This gas-engine is also direct connected to a generator for lighting the car.

Combined straight and automatic air brakes will be furnished, together with the usual auxiliary apparatus, and in addition to these brakes an auxiliary ratchet and hand brake is part of the equipment for emergency use. A radiator is placed on the roof of the car which provides an efficient means of cooling the engine on the thermo-siphon principle. During cold weather, hot water from the engine circulating system will be by-passed through the passenger compartments.

Although these cars can be geared for a speed of about 60 miles an hour on tangent level track, such speeds are not usually required on branch line service, and the Southern Railway cars will be geared for a somewhat lower maximum speed.

The ease of control and smoothness of acceleration are prominent features of this type of equipment, and are secured solely by reason of the gas-electric drive principle which it embodies. As there is no mechanical transmission between the engine and the axle, the speed of the engine is not a function of the speed of the car; consequently, the gas-engine may be operated so as to give its maximum output irrespective of the speed of the car —a characteristic which is of great value in case of emergency or heavy work. It has been found that the electrical equipment, consisting of the generator, controller and motors, and which takes the place of the gears, chains, sprockets, clutches and other mechanical means of transmitting the power of the gas-engine to the axle, is subject to very little maintenance expense, and the efficiency of this electric drive is high. The feature, perhaps, which will most strongly appeal to railway men is the simplicity of this control, and the ease and certainty with which it can be handled by an ordinary unskilled operator.

VARIATIONS IN PASSENGER CAR PAINTING PRACTICE

The rather remarkable variations that exist in car painting practice—remarkable considering the amounts of money involved, and the need of saving some of the present huge paint outlay—are presented in a paper read before the recent convention of the American Chemical Society by Carl F. Woods, of the Arthur D. Litttle, Inc., laboratory of engineering chemistry, in Boston.

As a sign of the present unscientific way of dealing with paint problems, Mr. Woods notes at the outset that although there has been in recent years a strong movement for the standardization of paint products, very little attention is being given to the proper application of the standardized paints themselves.

There is no class of painting in which this is more clearly illustrated than in that of car finishing, for this is not a comparatively simple operation like house painting, but on the contrary is a complex and highly skillful procedure, requiring expert labor and involving the application of many coatings.

The object of car painting is both for protection and for decoration, although the latter consideration has exerted the greater influence on the modern practice of car finishing. It is possible to preserve the woodwork of a car body just as efficiently by frequent painting with suitable oil paints as by covering.

it with the ten to fifteen coats of paint and varnish customarily applied. The steam or electric car operated on the surface, however, occupies a prominent position, and the public justly demands that it present a well kept exterior.

The cost of painting the same type of car varies on different roads from $30 to $60, and in certain cases an even larger amount. Some roads are forced to repaint their cars every two years, and others with the aid of one coat of varnish each year are able to operate for ten to fifteen years before complete refinishing becomes necessary. It is particulary significant that those cars that have had the most expensive finishing are not of necessity the longest lived. It is obvious, therefore, that there are certain underlying principles upon which the durability of the finish depends.

Car paints as a rule are mixtures of liquids and solids having widely different chemical and physical properties. While each succeeding treatment has its own specific demands, the entire paint coating must amalgamate and act as a unit to prevent separation of the various films under the physical stresses of service, produced by the expansion and contraction of the car under changes of temperature, and the wrenching and twisting incidental to operation.

There are four fundamental operations in car painting which must be performed to obtain the proper finish and the desired durability:

First, the pores of the wood must be thoroughly saturated to prevent the absorption of succeeding coats and to form a cementing bond between the wood and the paint films.

Second, the natural inequalities of the surface must be corrected and a smooth, hard foundation prepared for the application of the succeeding color and varnish coats.

Third, the required color must be applied in a smooth, homogeneous film which is sufficiently thick to cover the underlying coats and which at the same time possesses proper elasticity.

Fourth, the color coat must be covered with a film of varnish, both to protect the underlying paints from the effect of the weather and to obtain the glossy, smooth finish desired. It is necessary that this final coat be hard enough to withstand the abrasive action of sand and dirt and the general deteriorating effects of sun, wind and weather, but at the same time possess the maximum amount of elasticity.

Three distinct processes for car finishing are in use. These three systems may be called the "lead and oil," the "surfacer" and the "color and varnish" processes. Other methods of finishing are employed, but all of them are abbreviations or combinations of the three main types.

The "lead and oil" process, the oldest system in use, consists in thoroughly saturating the wood with a thin paint of white lead and linseed oil, followed after proper drying by thicker coats of the same paint until the wood work is properly "primed and filled." On the foundation so prepared several coats (usually three) of a special paint known as "rough stuff," are applied. This consists essentially of a mineral silicate of moderate fineness mixed with white lead and ground in varnish. Such a paint dries quickly and can be brought, by rubbing with blocks of pumice, to a smooth, slate-like finish, which affords an admirable surface for the body color. After a sufficient amount of color has been applied, the entire surface is given several coats of varnish, allowing each to dry thoroughly before adding the next.

The "surfacer" process was devised about thirty years ago to reduce the time, labor and expense of the old "lead and oil" system. The fundamental difference between the two processes is that the "surfacer" system omits the lead priming and filling and the "rough stuff" coats, but builds up the surface rapidly by the application of specially prepared paints. After the building-up coats have been laid, the entire surface is rubbed with block pumice to the desired finish. From this point on, the process is identical with the "lead and oil" system, the "surfacer" process confining its efforts to the rapid preparation of a surface for the color coat.

The "color and varnish" process is of very recent origin and is a radical departure from the older "lead and oil" and "surfacer" systems. The fundamental idea of the new process is that the fewer the number of coats and the more similar these coats are in composition, the more durable will be the final results obtained. With this in view, a combination of coats is applied which are so composed as to prime the wood, prepare a surface, and obtain the desired color at the same time. This is accomplished by employing heavy silicate paints, containing the proper color ground in the same kind of varnish, each coat possessing suitable drying qualities for its respective demands. The best results are obtained by the use of dark colors, such as green or brown, because the principal ingredient may be ochre, umber or some other natural earth pigment which not only produces the desired shade, but is well adapted for preparing a foundation. The surface so obtained is covered with a coat of the body color ground in varnish, followed by one thick coat of finishing varnish.

Each of the processes referred to has its specific faults and virtues. The "lead and oil" process, if properly applied, requires from three to four weeks and the application of ten or more coats. The "surfacer" process requires about the same number of coats, but, owing to the quicker drying of the surfacers, requires but two to three weeks for application. The "color and varnish" process is the simplest of all, and has been applied with apparently successful results in from six to eight days, with an application of four to six coats.

The faults of the "color and varnish" process are not as yet thoroughly understood, as the method is of very recent development and has not been subjected to the test of long continued service. It should be understood that the aim of this shorter process is durability at the lowest cost, and that appearance is in a measure sacrificed; but it is claimed that the finish obtained is fully as durable as by the older methods, that it is free from many of their faults, and that it produces a finished appearance sufficiently good for the purpose. On the other hand, the process is dependent upon specially made paints in which adulteration is difficult of detection, and which if carelessly made are not only short lived, but render more difficult the refinishing of the car. The system is only applicable to dark colors, as the lighter and more brilliant pigments do not possess sufficient covering power, but this is not in itself a failing, as the use of dark green and brown colors is rapidly increasing, owing to the greater stability and length of life obtained. In this connection it is of interest to note that the Pullman Company have adopted a brown body color as the most satisfactory shade available, while a large proportion of the railroads, both steam and electric, employ a color of similar nature.

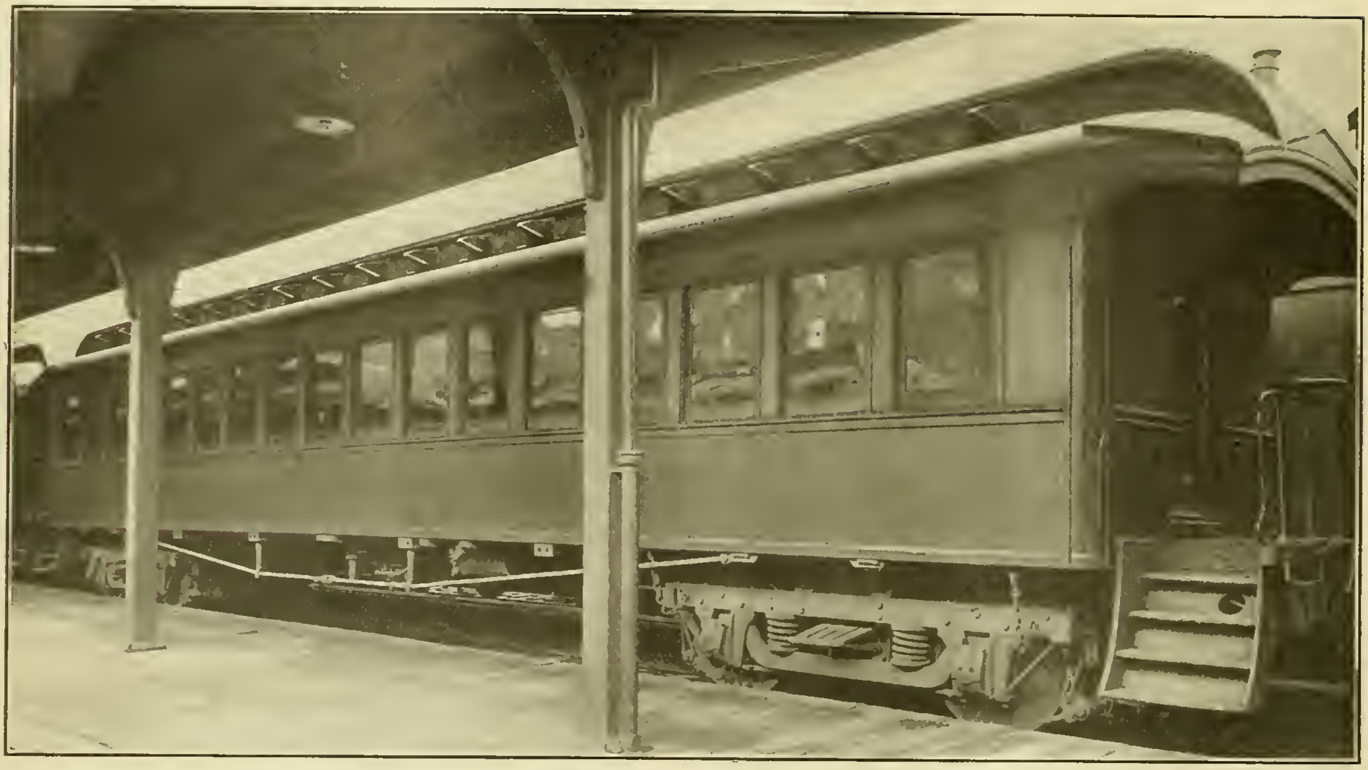
It has been shown by actual results that a saving of $20 to $30 can be made on the painting of each car and an increase in life obtained of from 5 to 10 years by the adoption of scientific methods of finishing. It is probable that no one of the methods in use embodies the maximum efficiency possible of attainment, and in view of the very large amount of money involved it is desirable that the entire subject be given careful study by technical chemists.

CARS AND LOCOMOTIVES ORDERED DURING 1909

Statistics compiled by *The Railway & Engineering Review* show that 3,233 locomotives, 185,445 freight cars, and 3,980 passenger cars were ordered during the year. This is very near the total of locomotives ordered in 1907, which was 3,482; but very much less than 1906, 5,642, and 1905, 6,265. The addition to tractive effort is not, however, clearly indicated by these figures, as the size and capacity of locomotives continues to increase.

3,980 passenger cars were ordered in 1909 as against 1,319 in 1908; 1,791 in 1907; 3,402 in 1906, and 3,289 in 1905.

185,445 freight cars of all kinds were ordered in 1909 as against 62,669 in 1908; 151,711 in 1907; 310,315 in 1906, and 341,315 in 1905, which was the largest year.

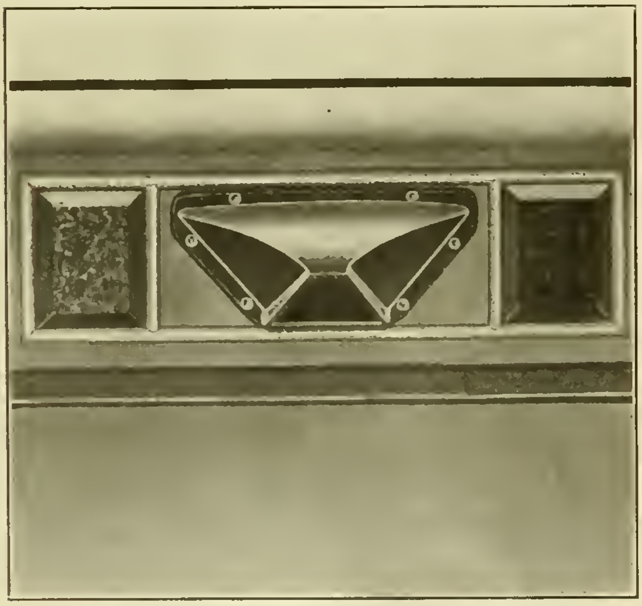


PASSENGER COACH WITH WARD EQUIPMENT COMPANY VENTILATORS.

PASSENGER CAR VENTILATOR.

As the result of a great deal of experimenting under actual service conditions, and extending over a considerable period of time, a passenger car ventilator has been developed by the Ward Equipment Company, of New York City, which is said to give practically ideal results. As a matter of fact, several cars equipped with this ventilator and operating under very severe conditions, as concerns ventilation, have been running for over a year with splendid results.

Some idea of the construction and application of the ventilator may be gained from the accompanying photographs. It is made in one piece and is of cast iron, so that it will not corrode when subjected to weather conditions, gases from coal, etc. The construction of the ventilator, with the sloping top and sides and the design at the bottom of the sides, is such that the air striking it is deflected downward, inducing a current of air from inside the car. An idea of the rapidity with which the air may be changed in the car may be gained from the fact that a smoking car filled with smoke may be cleared in from three to four minutes. Having a ventilator on every sash insures uniform ventilation throughout the car.



SHOWING APPLICATION OF VENTILATOR.

The design is such that cross winds are deflected and there are no down drafts on the heads of the passengers. It is impossible for rain, snow, cinders, dirt or dust to find their way into the car through the ventilators. Cars equipped with these ventilators have been used on runs through long tunnels where the traffic is very heavy; it was possible to leave all of the drop sashes in the car wide open without smoke or gases entering the car.

In applying the ventilator the drop sash is not disturbed and no change is necessary in the construction of the car. It is thus possible to apply it, if necessary, while the car is standing in the yards or in the terminal between runs. A small light of glass is placed on each side of the ventilator, thus increasing the volume of light in the clear-story and throughout the car. The wire gauze is done away with; this is very expensive to maintain because of rapid corrosion and is not very effective because of the holes becoming filled up with dust or dirt.

Self-Clearing Ash Pans.—The reports received by the *Block Signal and Train Control Board* up to November 1, 1909, cover a total of 50,879 locomotives. Of this number 26,336 are equipped with pans that are designed to meet the requirements of the law. The reports indicate that a further number of 19,676 locomotives are expected to be properly equipped before January 1, 1910. Of the total number of engines reported, 2,813 come under the exception in Section 6 of the law as not requiring ash pans, and 25 are to be retired from service before the end of the year. This leaves 2,029 locomotives, of the total number reported, which apparently remain to be equipped after January 1, 1910.

Receiverships in 1909.—According to the *Railway Age Gazette* the number of steam roads that went into the hands of receivers in 1909 was 5; their aggregate mileage, 859; their stock, $30,549,000; their funded debt, $47,546,000; and their total capitalization; $78,095,000.

HEAVY CONSOLIDATION LOCOMOTIVE.

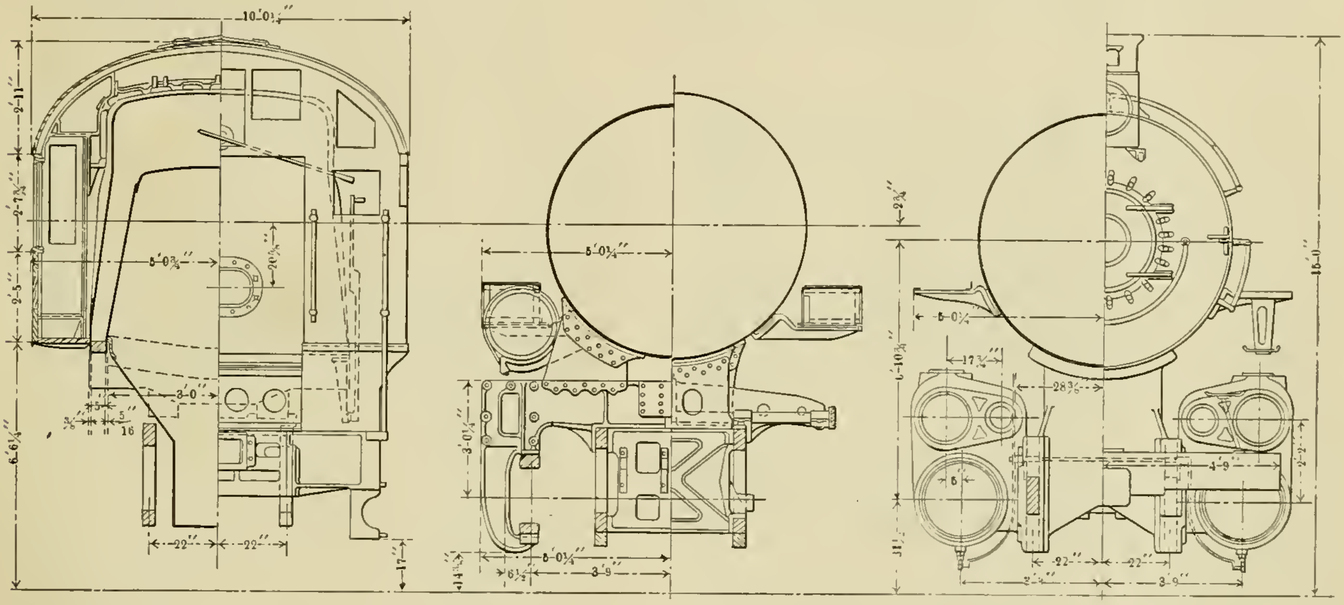
PENNSYLVANIA RAILROAD.

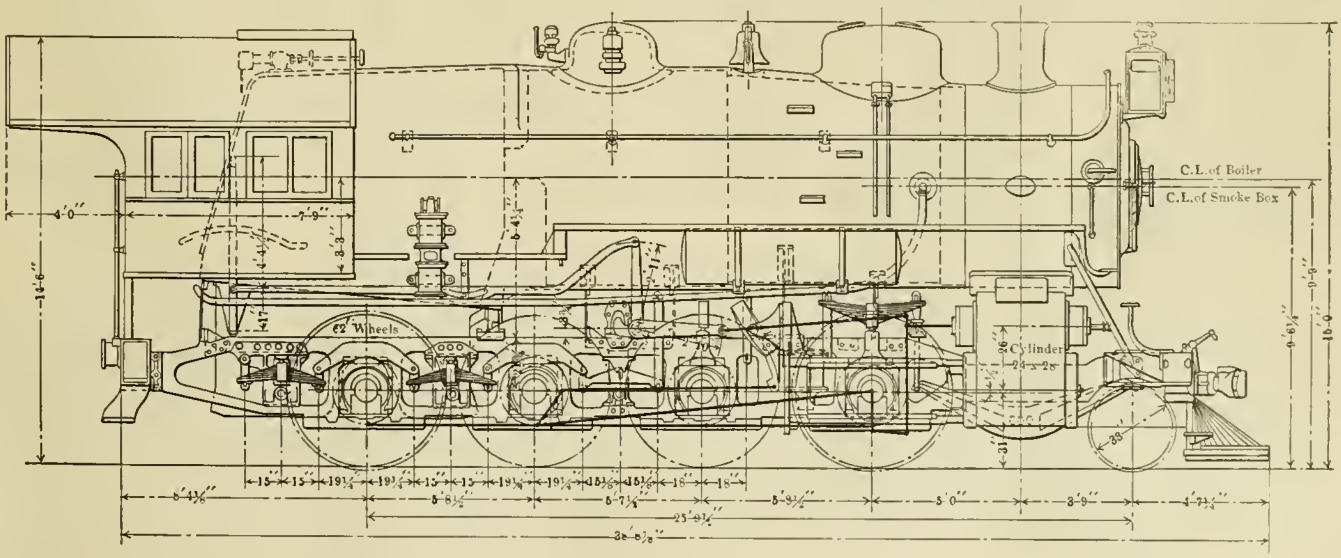
What is said to be the heaviest freight train ever hauled by one locomotive in this country, and probably in the world, was moved over the Pennsylvania Railroad between Altoona and Elona, Pa., on June 22, 1909, when locomotive No. 1113 pulled a train of 105 steel coal cars, loaded with 5,544 tons of coal, for a distance of 127 miles in seven hours and twelve minutes, or an average speed of 17.6 miles per hour.* The maximum grade over this section of the road is but 12 ft. to the mile. The total weight of the train, including engine, tender and caboose, was 7,644 tons, and the weight of the train behind the tender about 7,453 tons. The train was about 3,600 ft. long.

The locomotive that made this record was built at the Juniata shops of the Pennsylvania Railroad, and is one of what is known as class H8b. It was designed in the mechanical engineer's office at Altoona and is an excellent example of a very powerful consolidation engine equipped with drivers which permit moderately high speed and with sufficient heating surface to make such speeds, as for instance, 20 miles per hour, attainable for long distances at practically full tractive effort. A factor of adhesion of nearly five was adopted in order to be assured that the full power of the engine could be delivered even under difficult rail condiitons. A high factor of safety in a freight locomotive is also of great benefit in starting a heavy train out of the yards without the assistance of a pusher.

The illustrations show a number of the more interesting features of this locomotive. Possibly the most prominent impres-

* This record is claimed to have since been exceeded by a train on the Virginian Railway.





HEAVY CONSOLIDATION LOCOMOTIVE CLASS H8B—PENNSYLVANIA RAILROAD.

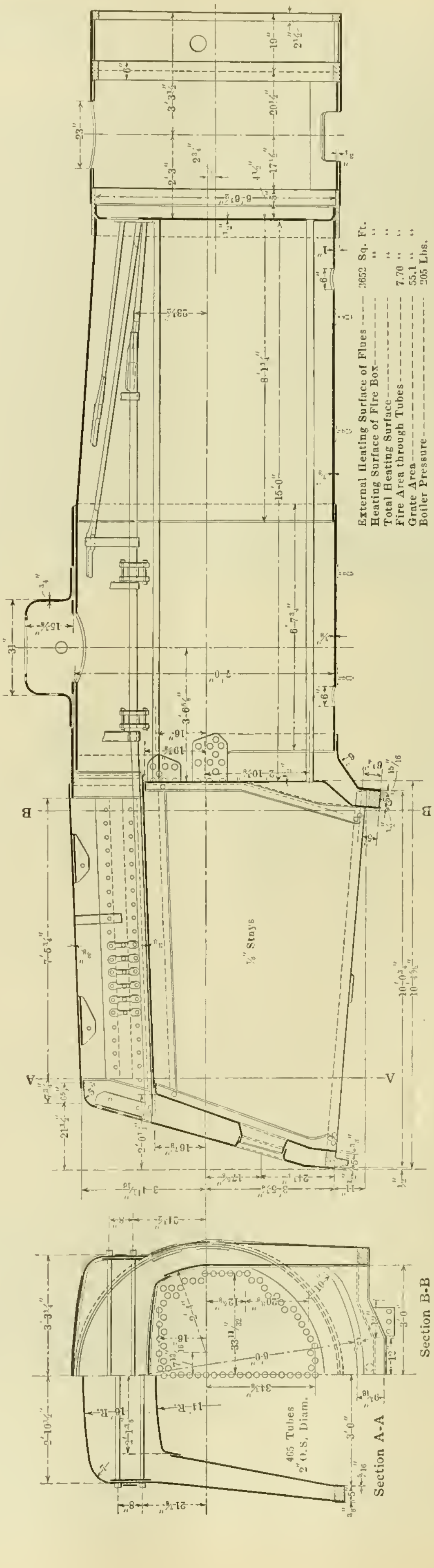
sion given by a general examination of them is that of massiveness. Because of the large power to be developed there was no occasion to save weight at any point, as great weight would be needed for adhesion, and as a result massive steel castings, of undoubted strength, are found at every point where weakness might occur. This feature is particularly noticeable in the bracing of the frames, which is unusually well taken care of.

Boiler.—A boiler of sufficient capacity is, of course, the most important feature of the design of a locomotive intended for what might be termed "capacity" work on a railroad, either freight or passenger. A study of the boiler drawing and of the table of heating surfaces and ratios shows that this feature was well recognized and had been given careful study. The design of the boiler, however, must necessarily be dependent to a considerable extent on the fuel available and while with the fuel conditions of some roads this boiler would probably not give the full locomotive capacity at 20 miles per hour, under the proper conditions is undoubtedly will do so and in fact service tests of long duration have demonstrated this. The shell has but two courses, the front one being the conical course, measuring 78½ in. outside diameter at the front end and 84 in. at the back end, the sheet being 8 ft. 1¼ in. in length. The second course is of uniform diameter and is 7 ft. 2¼ in. in length; it is in the center of this course that the dome is located. The design of the dome is somewhat unusual; it is made of ¾ in. steel plate pressed into shape; its outside diameter is 31 in. and its height above the shell 15⅞ in.

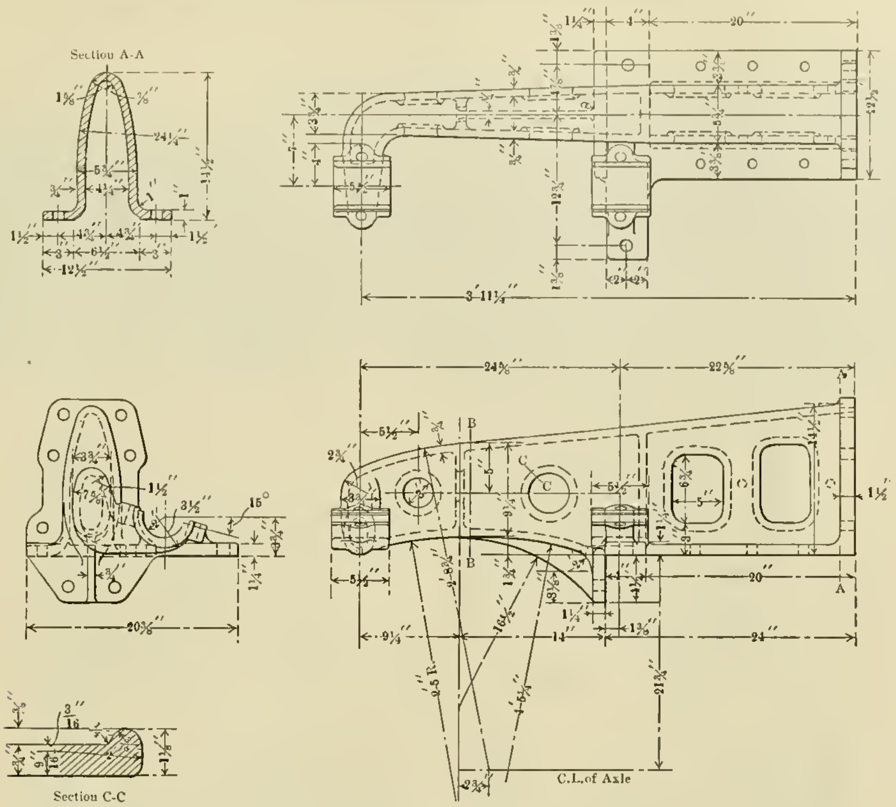
The firebox is of the customary Pennsylvania Belpaire type with a 5 in. mud ring. The side sheets, both inner and outer, are straight at the back and bellied out to fit the shape of the shell at the forward end. The back tube sheet is set in some distance from the face of the mud ring, as is shown in the longitudinal section. The boiler illustration shows the location of the interior feed pipe, which connects to the double check valve on the back head of the boiler and discharges at a point about 3 ft. back of the front tube sheet and above the top of the tubes. This pipe is about 4 in. higher at the front than at the back end, so that it drains toward the check valve. The tubes are but 15 ft. in length, but number 465, giving a heating surface of 3,652 sq. ft.

Frames.—The frames are of wrought iron or cast steel in two sections, the connection being between the first and second pedestals at a point directly beneath the guide yoke. They are normally 4 in. in width and measure 8 in. in depth over the pedestals, and at other points from 4 to 7 in. on the various rails. They are forged to include the seats for the vertical keys holding the saddle and cylinder castings, both front and rear. The front section of the frame extends continuous to the bumper beam. The frame bracing, as above mentioned, is ample, the principal braces being a broad steel casting placed horizontally across the frames above the first pedestal; a heavy vertical frame brace just beneath the guide yoke, which supports the brake cylinders; a heavy brace, across between the second and third pedestals, consisting of a horizontal steel casting over 30 in. in width, below which is a substantial casting placed vertically and connecting to all four rails, this being also bolted to the horizontal brace; also, just back of the third pedestal is a brace which supports the forward end of the mud ring. The frames are secured to the boiler between the cylinders and the front mud ring by four belly braces. The front bumper beam is also most substantial, consisting of three steel castings, one between the frames, including the guide for the truck pin, and two outside the frames for wing castings. None of these are fastened to the cylinders. A similar design is found at the tail casting, which is in three parts, all being arranged to lip over the frames at the top, where they are secured together. The arrangement of the spring rigging and equalizers is clearly shown in the illustrations.

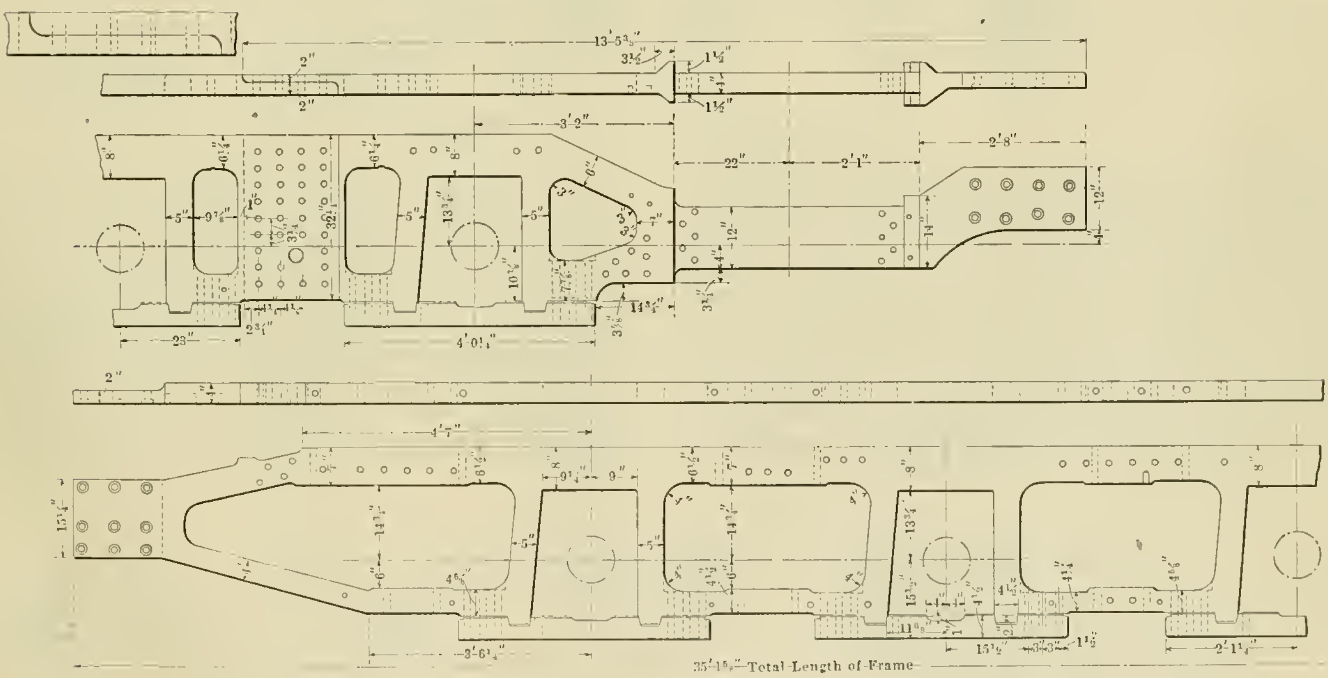
Guide Yoke.—The guide yoke is formed of two duplicate steel castings, joined on the center line. It is securely fastened to the frames by both vertical and horizontal bolts and is also



BOILER OF CLASS H8B LOCOMOTIVE—PENNSYLVANIA RAILROAD.



SUPPORT FOR REVERSE SHAFT.

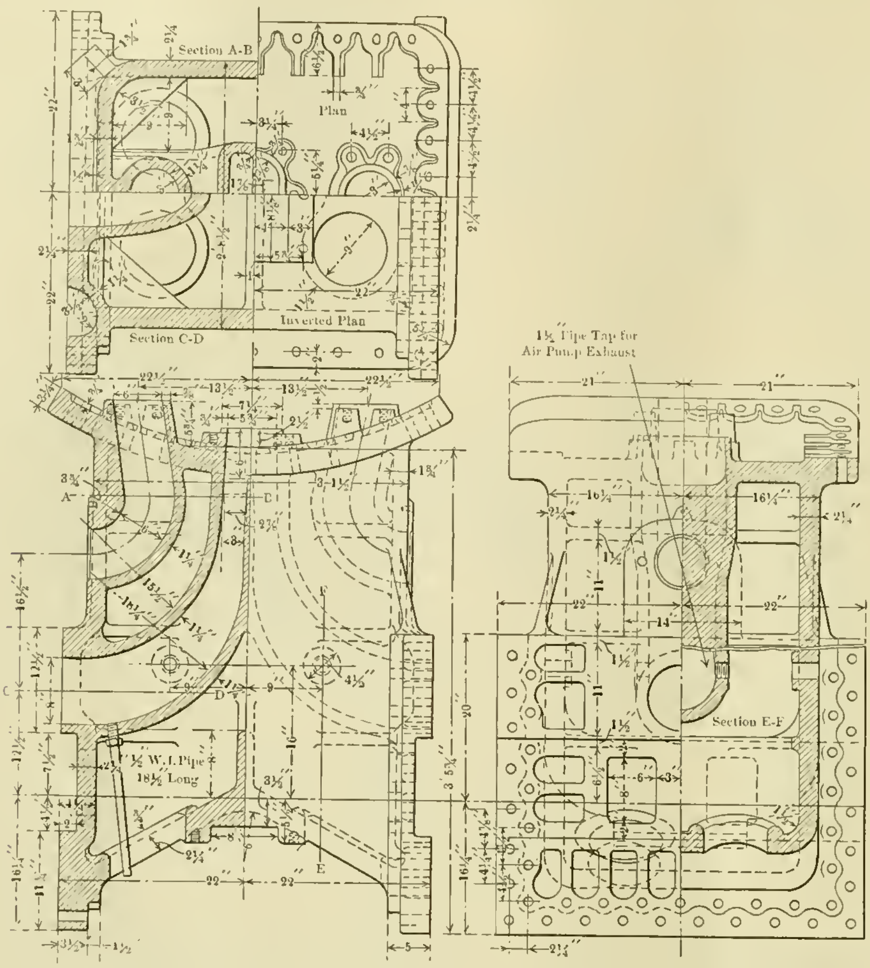


FRAMES—CLASS H8B CONSOLIDATION LOCOMOTIVE—PENNSYLVANIA RAILROAD.

bolted to the vertical frame brace. The bearing for the link trunnions is secured to the outer end of the yoke, as is shown in the illustration.

Reverse Shaft Support.—An interesting design in cast steel is found in the support for the reverse shaft located on top of the frame between the second and third drivers. This has an extension outside the frames and carries a bearing for the outer end of the reverse shaft, the arm of which connects to the radius bar of the valve gear through a slip joint. This support, in section, is in the shape of an inverted U, giving great stiffness without excessive weight.

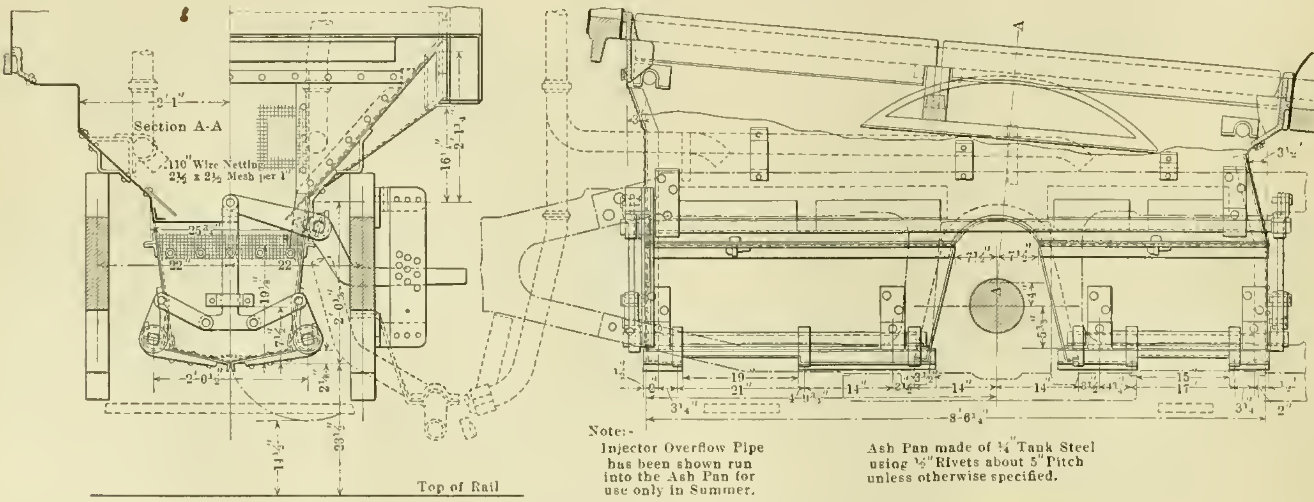
Cylinders.—As is customary on the Pennsylvania Railroad, the cylinders are cast separate from the saddle. The saddle casting in this case has a passage which conveys the steam from the steam pipes and emerges in the center just above the frames, where it is continued by a short steam pipe with a slip joint connecting to the center of the valve chamber. The exhaust passage in the saddle is single and connects to its continuation in the cylinder casting directly, without the use of an extra pipe. In the cylinder casting the exhaust passage divides and emerges front and back just back of the valve chamber. The valve chamber heads are specially designed to connect and furnish the passage for the exhaust steam from the end of the valve chamber to this passage in the cylinders. In this manner the castings for both cylinders and saddle are very much simplified and are capable of being designed with greater assurance than is pos-



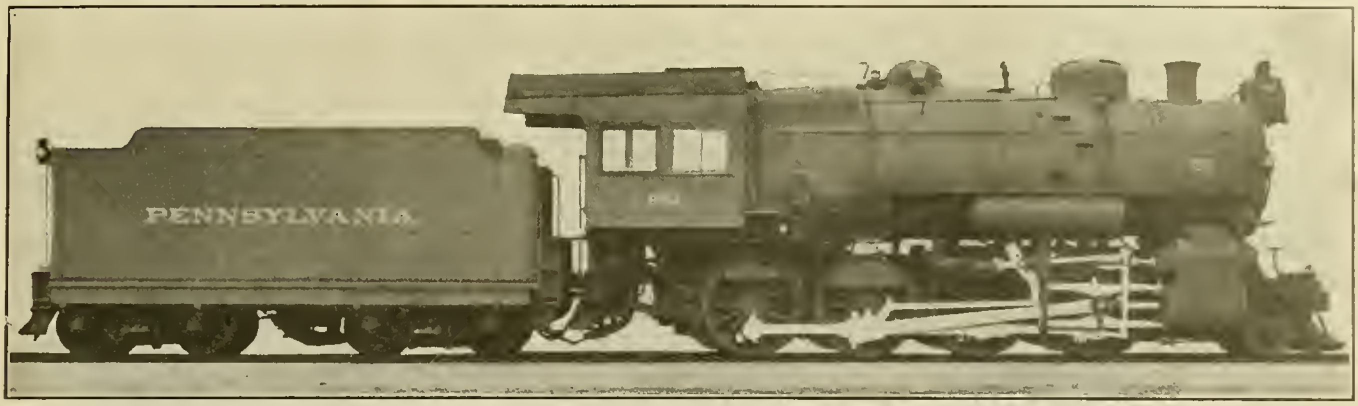
SADDLE CASTING—CLASS H8B LOCOMOTIVE.

sible where the passages are all contained in one casting. The illustrations show the details. The frames are in slab form 12 in. in depth, where they pass between the cylinders and saddle and are set into recesses in both of these castings, which are secured together above and below as well as through the frames.

Valve Gear.—A design of Walschaert valve gear, which is all in one vertical plane has been permitted by setting the valve chamber 5 in. outside the center line of the cylinders. The valve gear is a very straightforward simple arrangement. The valve stem connects to a crosshead supported by a bracket set on top of the guides, to which is also connected the combination lever. The link is supported back of the guide yoke, and its lower extension at the connection for the eccentric rod has a lever arm of 24½ in., bringing this point almost to the center line of the drivers. The path of the pin on the return crank, or double the amount of eccentricity, is 22¾ in. and the length of the eccentric rod is such that the bottom of the link swings farther back than forward of the vertical center line dropped from its trunnion, in order to improve the steam distribution. The reversing is done through a slip joint on the radius bar, which extends back of the link, the arm on the reversing shaft being 2 ft. 10 in. in length.

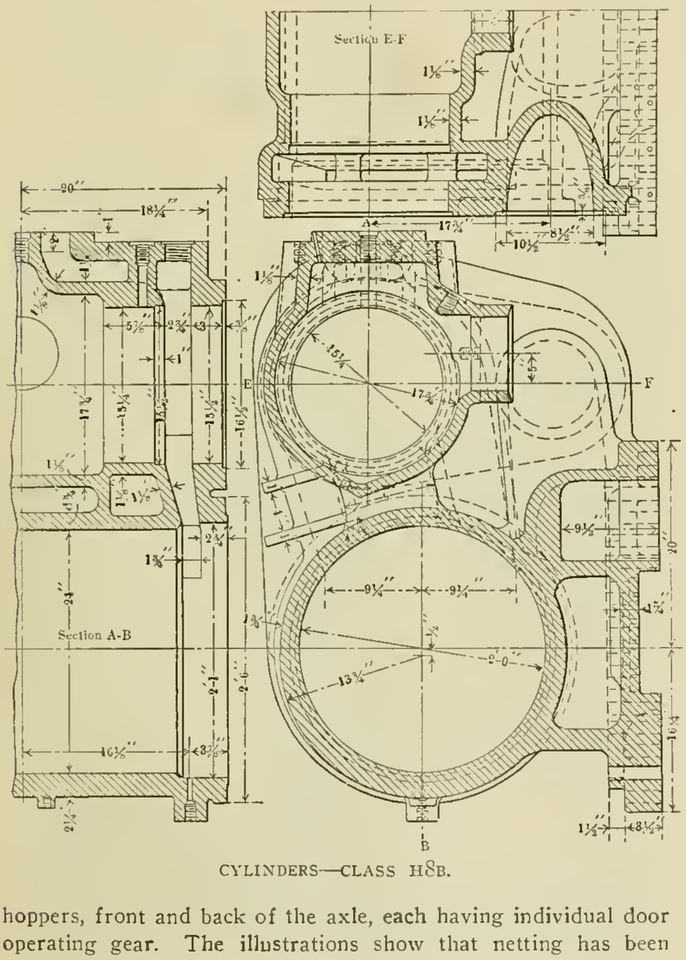


SELF-CLEARING ASH PAN FOR CONSOLIDATION LOCOMOTIVE—PENNSYLVANIA RAILROAD.



PENNSYLVANIA RAILROAD CLASS H8B CONSOLIDATION LOCOMOTIVE.

Ash Pan. One of the illustrations shows a design of self-clearing ash pan of large capacity, that has been applied to these locomotives. Its greatest point of interest is in the design and method of operating the doors, which in this case are hinged on either side and swing downward and outward. They are held in a closed position by a toggle joint arrangement, which insures them being securely fastened when closed without putting any great strain on the dumping gear. There are two large



CYLINDERS—CLASS H8B.

hoppers, front and back of the axle, each having individual door operating gear. The illustrations show that netting has been liberally used, both at the front and rear of the pan, and that no air openings are provided on the sides.

The general dimensions, weights and ratios are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	42,661 lbs.
Weight in working order	238,300 lbs.
Weight on drivers	211,000 lbs.
Weight on leading truck	27,300 lbs.
Weight of engine and tender in working order	396,300 lbs.
Wheel base, driving	17 ft. ½ in.
Wheel base, total	25 ft. 9½ in.
Wheel base, engine and tender	59 ft. 5⅝ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.95
Total weight ÷ tractive effort	5.60
Tractive effort × diam. drivers ÷ heating surface	690.00
Total heating surface ÷ grate area	69.64
Firebox heating surface ÷ total heating surface, per cent	4.88
Weight on drivers ÷ total heating surface	54.96
Total weight ÷ total heating surface	62.05
Volume both cylinders, cu. ft.	14.66
Total heating surface ÷ vol. cylinders	261.91
Grate area ÷ vol. cylinders	3.76

CYLINDERS.

Kind	Simple
Diameter and stroke	24 x 28 in.

VALVES.

Kind	Piston
Diameter	14 in.
Greatest travel	6 in.
Steam lap	⅞ in.
Exhaust clearance	⅛ in.
Lead	3/16 in.

WHEELS.

Driving, diameter over tires	62 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 13 in.
Driving journals, others, diameter and length	9½ x 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	5½ x 10 in.

BOILER.

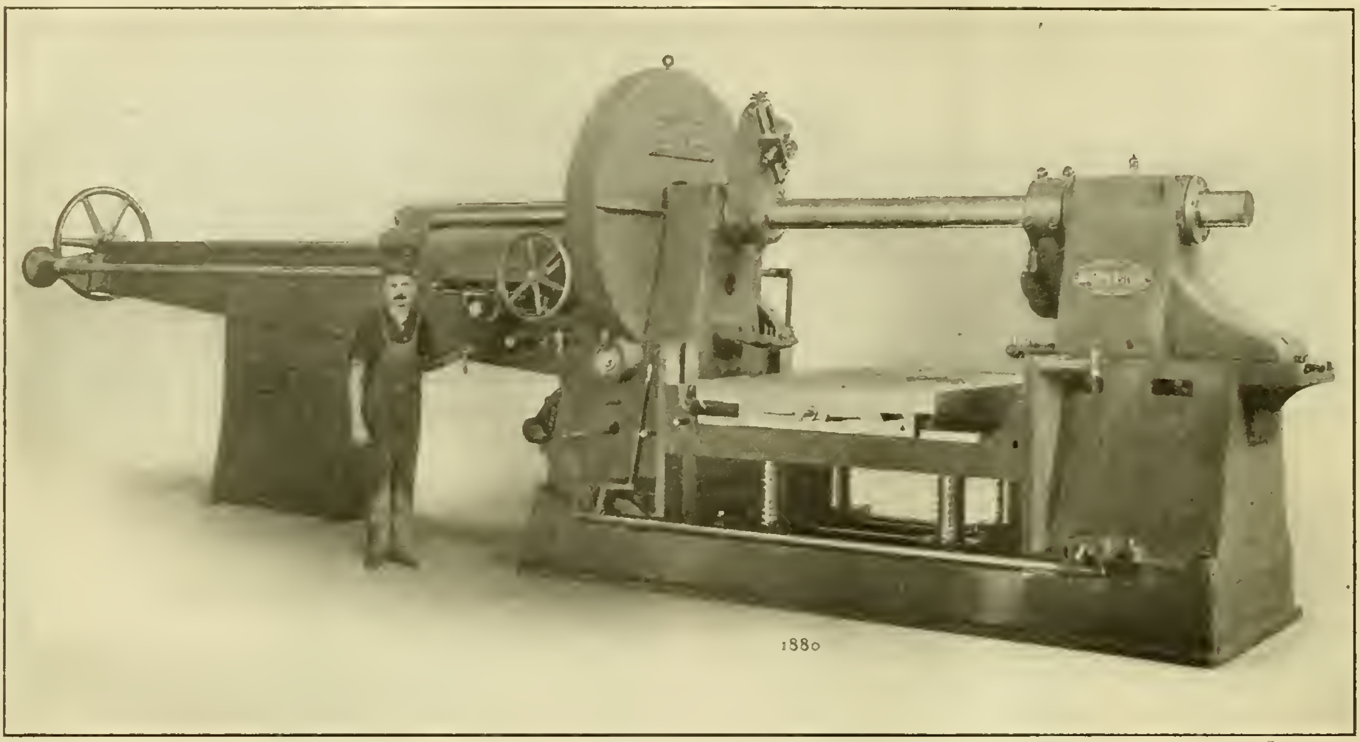
Style	Belpaire
Working pressure	205 lbs.
Inside diameter of first ring	76¾ in.
Firebox, length and width	110¼ x 72 in.
Firebox plates, thickness	5/16, ⅜, ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	465—2 in.
Tubes, length	15 ft.
Heating surface, tubes	3,652 sq. ft.
Heating surface, firebox	187 sq. ft.
Heating surface, total	3,839 sq. ft.
Grate area	55.13 sq. ft.
Smokestack, min. diameter	17 in.
Smokestack, height above rail	180 in.
Center of boiler above rail	117 in.

TENDER.

Weight	158,000 lbs.
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,000 gals.
Coal capacity	17.5 tons

Panama Canal.—Estimates of the sums required for the most economical conduct of the construction work during the next fiscal year amount to $48,000,000. This total is larger than those unfamiliar with the conditions at the Isthmus anticipated, but the reasons for it are sound. The rate of progress now is very high, amounting during September to 2,840,000 cu. yd. of excavation, 452,000 cu. yd. of fill-in dams, and 21,500 cu. yd. of concrete. The heavy interest charges on the great sums already spent make it advisable to push the work to the full economical capacity of the plant and organization. This capacity is greater than was anticipated, and consequently it is advisable to spend more each year and complete the canal sooner than will be possible with smaller annual appropriations.—*The Engineering Record.*

Accurate Measurements.—A mechanic with his caliper gauge can readily detect differences of 1-10,000 of an inch; and a good tool maker with suitable parallel jaw calipers can detect differences of about 1-50,000 of an inch. Experts can detect a difference when working on small wires of one or two thousandths of an inch by the sense of touch or feeling and without the use of calipers.—*H. De B. Parsons.*



BEMENT-MILES CYLINDER AND PISTON VALVE CHAMBER BORING MACHINE.

LOCOMOTIVE CYLINDER AND PISTON VALVE CHAMBER BORING MACHINE.

The locomotive cylinder and piston valve chamber boring machine, shown in the illustration, will bore and face both ends simultaneously of cylinders up to 60 in. in length. This design has just been brought out by the Bement Works of the Niles-Bement-Pond Company. The boring bar is a steel forging 7 inches in diameter, has a continuous traverse of 11 feet by hand, fast power traverse in either direction, and automatic reversible boring feeds. The feeds are six in number and are actuated by a screw through a protected nest of gears; they are engaged, changed or reversed by a conveniently placed lever. The screw feed is of special advantage when boring piston valve chambers where the cutting is not constant, but is interrupted.

The main table is supported on four large elevating screws, the nuts of which are revolved by hand or power. The cross table is 54 inches wide in the direction of the machine's length by 72 inches long transversely; the top surface is fitted with T-slots for clamping the work. The table has a cross traverse of 30 inches and a longitudinal traverse of 18 inches by hand. The minimum distance from the center of the boring bar to the table is 30 inches, and the maximum 51 inches.

The facing heads are provided with tool slides having compound motion and are clamped in the boring bar sleeves. They have automatic star feed, and when not in use may be allowed to hang in place. The minimum distance between the facing heads is 20 inches, and the maximum 60 inches. When ordered, boring heads of various sizes may be provided to meet requirements. The machine is driven by a 20 horse-power motor geared direct and operated by a reversing controller. The same motor raises and lowers the table and operates the fast traverse to the bar.

Headlights in Indiana.—The Railroad Commission of Indiana, after considerable investigation, has issued an order directing that headlights of 1,500 candle-power be used. The Indianapolis *News*, in commenting on this, says: "No oil lamp has yet been devised, as far as the commission could learn, which will attain the required candle-power, unless it be some modified form of the gasoline lamp. It is expected that the new lamps to be put in will be either electric or acetylene. Concerning a choice between these two, the commission has nothing to say."

SUPPLYMEN'S ASSOCIATION AT THE ATLANTIC CITY CONVENTIONS.

John D. Conway, secretary of the Railway Supply Manufacturers' Association, 313 Sixth avenue, Pittsburgh, Pa., has issued a circular announcing the principal features of the arrangements for the Master Car Builders' and Master Mechanics' conventions at Atlantic City, N. J., June 15-22 next. The exhibits and the offices of the association will be located on Young's Pier as before, with the exception of the track exhibits, which will be placed as they were in 1909, on the tracks of the Philadelphia & Reading Railway, about 200 yards from the convention pier.

Contract has been let for the erection of exhibit structures. It provides for 69,000 square feet of exhibit space, exclusive of aisles, and 40 cents per square foot will cover the cost of erecting structures and providing the usual facilities. The color scheme will again be green and white. A telephone will be provided between every two exhibitors with free local service from Monday, June 13, to Thursday, June 23. The upper floor of Exhibition Hall will not be used, and the lower floor will have ceiling and walls calcimined white. Eight candle-power electric lamps will be placed 2 feet apart along each of ten cornice lines and will be lighted throughout the day, so that each aisle will have two rows of these lights and each booth a row at the front and a row at the back. Annex court contains large spaces which may be built largely to suit occupants. The annex will have the column and panel construction substantially as in 1909, but very heavy exhibits cannot be placed on this end of the pier. Exhibits of medium heavy weight can be put in the addition to the hotel men's annex in the side spaces, as these are over concrete piles, but only light exhibits can go in the center spaces.

Power for operating exhibits will be furnished as heretofore. An additional boiler and a larger motor-driven compressor will be installed, and it is expected that with these additions all reasonable demands can be met.

Application for space should reach the secretary by January 31. On February 16, in Pittsburgh, space will be assigned to all exhibitors who have made application prior to that date, and the procedure will be substantially the same as in 1909. The exhibitors, if any, whose requirements, in the judgment of the exhibit committee, make it imperative that they be specially taken care of, will be assigned space first. Lots will then be drawn to determine the order in which exhibitors may choose space. If a representative of the exhibitor is present, he may choose in his turn; if there is no representative present, the application will be used as a guide in assigning the best space possible. The number of advance applications already received indicates a very great demand for space.

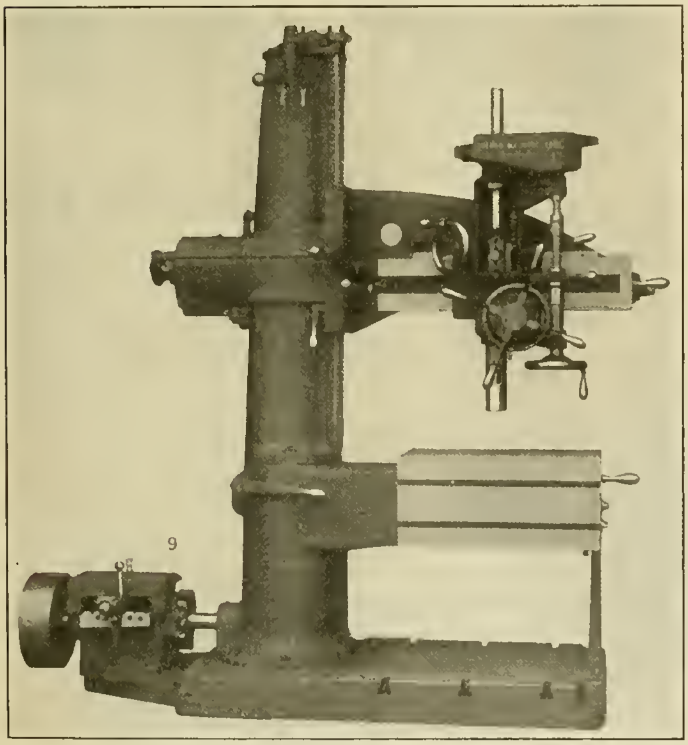
Mr. Conway calls attention to the resolution of the executive committee, prohibiting the distribution of souvenirs at the conventions; and also to the rule prohibiting the distribution of advertising matter from booth to booth.

NEW 36-INCH DRESES RADIAL DRILL.

The Dreses Machine Tool Company, Cincinnati, Ohio, in redesigning its line of radial drills, has given special attention to simplicity in the driving mechanism. One pair of bevel gears is carried inside of the column, thus obviating the use of the customary spur gears, one shaft and two bearings. The arrangement for transmitting the power to the drill spindle from the bevel gears remains the same as that used on previous designs.

The elevating screw is placed in a recess in front of the column, protecting it from damage and not impairing the swing of the machine. The lever protruding through the arm, near the column, operates a double friction which starts, stops, engages the back gears and reverses the spindle for tapping; any of these changes may be made while the machine is running. The lever above the one just mentioned sets the machine for tapping and also reverses the spindle at a ratio of 5 to 7, while the former lever reverses the spindle at a ratio of 1 to 4 forward and backward. A knurled screw on the main operating lever adjusts the gripping power of the driving friction clutch so that taps will not be broken off when striking the bottom of the hole.

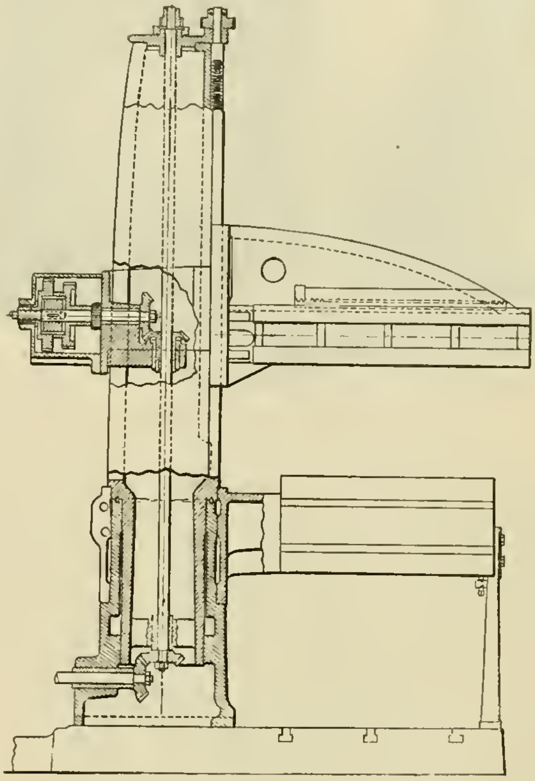
The head is moved on the arm by a rack and spiral pinion and



NEW DESIGN OF DRESES RADIAL DRILL.

is clamped by the lever at the rear of the vertical shaft carrying the worm that drives the feed. The quick return is through the four-handled pilot wheel which automatically engages and disengages the feed. The feed is of the all-geared type. It has four changes which are varied by a ducking key in connection with the knurled shiftable knob on the vertical worm shaft. The spindle has an automatic stop and is graduated for depth. The teeth are cut away at the extreme end of the rack to avoid breakage when the spindle is fed to the limit of its travel.

A novel feature of the machine is the connection of the column carrying stump, column and table. The column fits into the stump and rests on rollers for easy movement. The table encircles the lower stump and a small part of the column and by depressing the lever shown in front, a screw binds all three substantially together. This lever is always within reach of the left hand of the operator, without changing his position.



DRESES RADIAL DRILL.

A tension screw below the lever always insures a working fit. The table is supported at its outer end by a stand having an adjusting screw so that it can always be kept at right angles with the spindle.

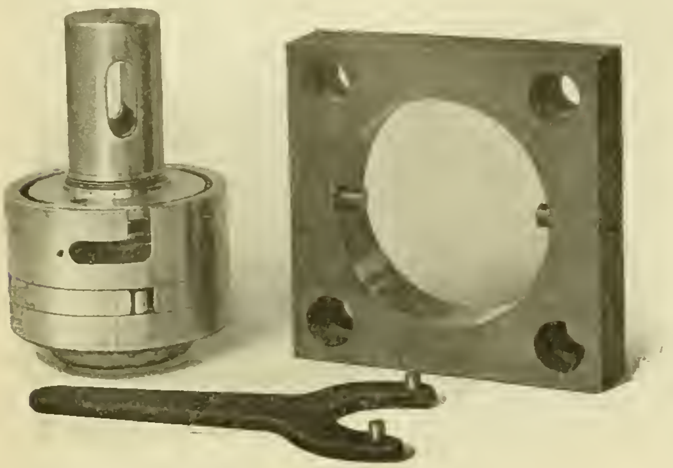
The machine is built with a cone pulley for belt drive, or constant or variable speed motors may be mounted on an attached sub-base. It drills to the center of a 73-in. circle, takes 58 in. under the spindle, and weighs about 3,600 pounds.

An Elaborate Train Ferry.—The train ferry between Sassnitz, Germany, and Trelleborg, Sweden, a distance of 65 miles, was placed in operation by the two governments during the past summer. The ferries make the passage in four hours. Each is 370 ft. long over all, 53½ ft. wide, has a maximum speed of 16½ knots and will carry eight cars. The boats are fitted as passenger steamers, and in addition to carrying the cars have dining room, smoking room, and berth accommodations for 141 passengers. The staterooms are below the car deck, and provision is made for the first-class dining room and smoking room on a separate deck over the cars.—*The Engineering Record.*

Delay to Passenger Trains.—The monthly report of delays to passenger trains on the steam railroads in the State of New York, issued by the Public Service Commission, Second District, shows that for the month of October 56,230 trains were run, of which 84 per cent. were on time at division terminals. The average delay for each late train was 24 minutes, and the average delay for each train run was 3.9 minutes. The principal causes of delay were waiting for trains on other divisions, 30 per cent.; train work at stations, 16.5 per cent.; waiting for train connections with other railroads, 14.7 per cent.; meeting and passing trains, 7.5 per cent.; wrecks, 5.2 per cent.

FLOATING REAMER HOLDER FOR VERTICAL TURRET HEAD BORING AND TURNING MILLS.

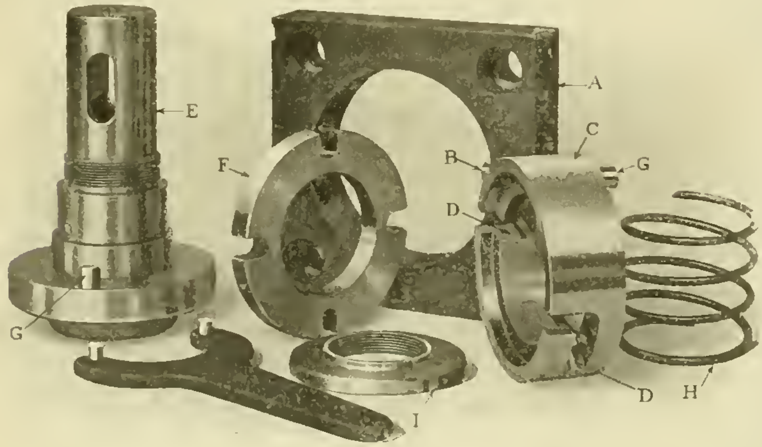
A floating reamer holder that has a number of advantages making it a most valuable appliance for users of vertical turret head boring and turning mills has been placed on the market



FLOATING REAMER HOLDER ASSEMBLED.

by the Colborn Machine Tool Company, of Franklin, Pa. Any make or style of reamer, whether solid or shell, adjustable or non-adjustable, can be used, it being only necessary that it have a Morse taper shank. The holder can be used on any make or style of vertical boring mill having a turret with flat sides.

Users of chucking machinery appreciate the advantage of using a floating reamer on the final finishing of the work, before removing it from the machine. When a reamer is held rigidly in position it is liable to produce a taper hole or ream the hole too large. With any machine like a boring mill, having a turret with a cross movement, the floating reamer is indispensable. This type of machine depends upon a center stop to bring the turret holes into alignment with the main spindle to which is attached the chuck or holding

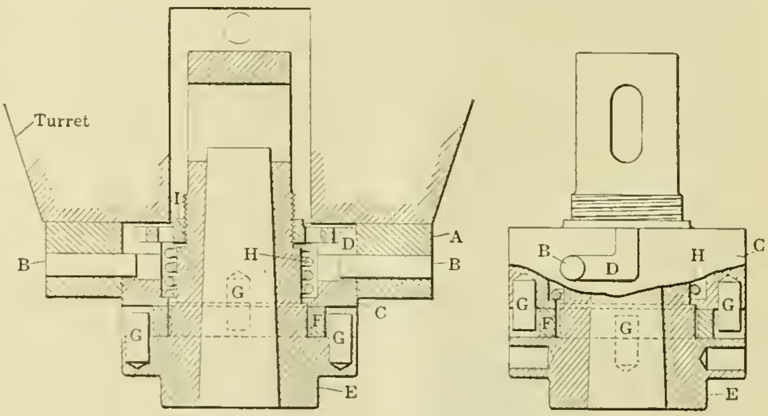


DETAILS OF FLOATING REAMER HOLDER.

fixture. Unless special care is exercised the operator will not bring the turret back to exactly the same position every time, even with the positive stop. The pressure of the hand on the crank handle is very likely to vary enough to change the exact alignment of the turret and the spindle a few thousandths of an inch, and reaming a hole with a reamer rigidly fixed in the turret would, under these conditions, cause the hole to be tapered or enlarged to a greater or less degree. This may be overcome by having the reamer so held that its axis is always maintained parallel to the center of hole, but at the same time so arranged that it has a slight self-adjusting tendency radially so that the hole and reamer will automatically keep in perfect alignment with each other This is what is accomplished by the use of the device shown in the illustration.

Referring to the drawing: Plate A is made to fit the face of the turret on any size or make of boring mill, and is fastened to it by four filister head screws. Sleeve C is held in plate A by two steel pins B, which are tight in plate A and made to fit freely in bayonet grooves D. Reamer holder E floats on sleeve C, the floating motion being obtained through the four steel pins G extending into the driving ring F. Two of the pins are tight in the holder E and two in sleeve C. The faces of sleeve C, driving ring F, and reamer holder E are held tight against each other by means of spring H, which insures the reamer being held true. Spring H is adjusted by means of nut I, which is turned with a spanner wrench furnished with each holder. It will be seen that plate A is the only part of the device that has to be made special to fit different makes of boring mills.

The photos show the various parts of the device in detail and assembled. The holders are made in two sizes, the No. 1 having a No. 4 Morse taper socket and capable of holding



FLOATING REAMER HOLDER.

reamers up to 3 inches in diameter, the No. 2 having a No. 5 Morse taper socket and capable of holding reamers up to 4 inches in diameter.

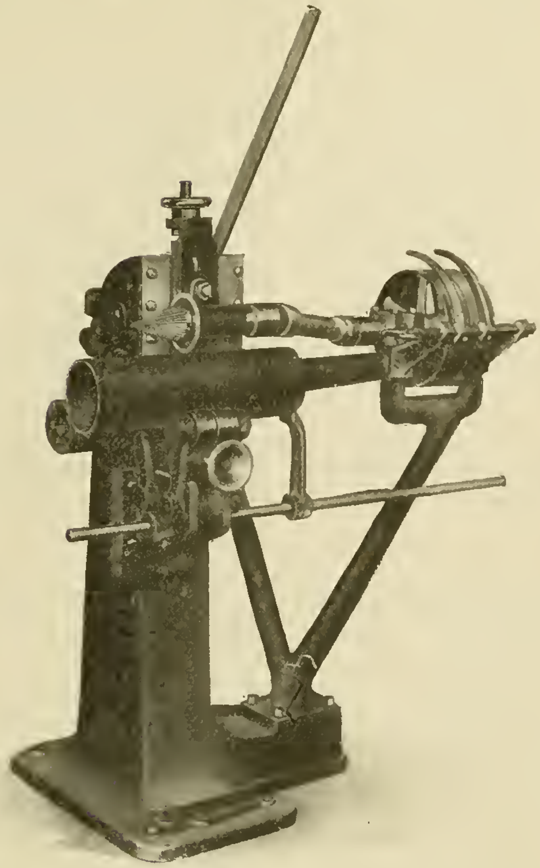
INTERNATIONAL RAILWAY FUEL ASSN.

The second annual meeting of the International Railway Fuel Association will be held at Hotel La Salle, Chicago, Ill., on May 23, 24, 25 and 26, 1910. The papers to be presented at the meeting and the committees in charge are as follows:

"Grade of fuel most suitable for locomotive use, considering cost per unit of traffic and best interests of producer. Recommended methods of preparing coal as to size for locomotives." J. G. Crawford, chairman, fuel engineer C., B. & Q. R. R., Chicago; Le Grand Parish, S. M. P., L. S. & M. S. Ry., Cleveland, Ohio, Curtis Scovill, A. G. S. A., Central Coal & Coke Company, Dallas, Texas.

"Standard uniform blank for reporting all items of cost in connection with fuel stations and handling fuel, for all types of stations and conditions." R. Emerson, chairman, Asst. to Gen. Mgr., Lehigh Valley R. R., So. Bethlehem, Pa.; F. V. Hetzel, chief engineer, Link Belt Co., Nicetown, Pa.; E. A. Averill, editor American Engineer and Railroad Journal, New York, N. Y.; N. M. Rice, G. S. K., A. T. & S. F. Ry., Topeka, Kans.

"Accounting for fuel consumed. Individual records of performance." W. E. Symons, chairman, C. G. W. Ry., Chicago; E. A. Foos, C. C. Fuel, Rail and Tie Dept., C., B. & Q. R. R.,



FLUE CUTTING MACHINE WITH 6-INCH TUBE IN POSITION TO BE CUT.

Chicago; E. J. Roth, Jr., fuel inspector, B. & O., Baltimore.

"Methods of purchasing fuel with regard both to traffic conditions and to producers interests. Relation between producer and railroad." W. H. Huff, chairman, V. P., Victor-American Fuel Co., Denver, Colo.; L. L. Chipman, G. S. M., Fidelity Coal Mining Co., Kansas City, Mo.; W. K. Kilgore, fuel agent, C. M. & St. P. Ry., Chicago.

"Methods of supervision, instruction and encouragement in locomotive operation to secure greatest efficiency in fuel consumption." D. Meadows, chairman, Asst. Div. M. M. Michigan Central R. R., St. Thomas, Ont.; W. C. Hayes, Supt. Locomotive Operation, Erie R. R., New York, N. Y.; J. McManamy, R. F. of E., Pere Marquette R. R., Grand Rapids, Mich.

"Character of membership that should be encouraged in the association and steps to secure that membership." S. L. Yerkes, fuel agent, Queen & Crescent System, Lexington, Ky.

"Methods of kindling locomotive fires." C. F. Richardson, Asst. to G. S. M. P., C. R. I. & P. Ry., Chicago.

The officers of the Association are: Eugene McAuliffe, president, 'Frisco Lines, Chicago, Ill.; W. C. Hayes, first vice-president, Erie Railroad, New York, N. Y.; J. H. Hibben, second vice-president, M. K. & T. Ry., Parsons, Kans.; D. B. Sebastian, secretary, C. R. I. & P. Ry., 327 La Salle Station, Chicago; J. McManamy, treasurer, Pere Marquette R. R., Grand Rapids, Mich.

FLUE CUTTING MACHINE.

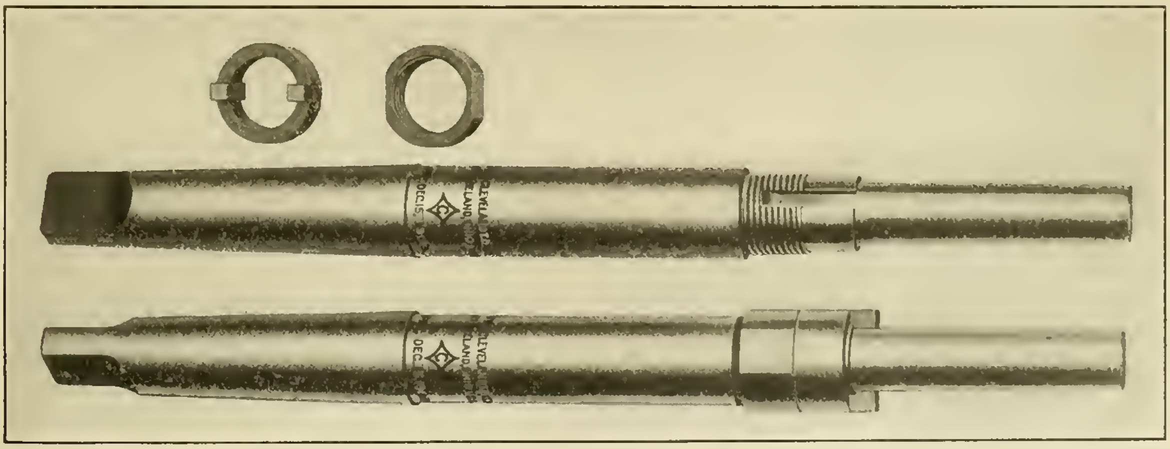
A flue cutting machine, having a capacity for cutting tubes or pipe from 3/8 to 6 in. in diameter has been placed on the market by Joseph T. Ryerson & Son, of Chicago, Ill. The machine is very rapid in operation. The cutter wheel is direct connected by means of a knuckle joint shaft to a 12 by 3 in. pulley, which operates at about 200 r.p.m. The object of the knuckle joint drive is to permit the tubes or pipes to be run out back of the machine so that they may be cut to any desired length. The feed of the cutter is accomplished by means of the hand lever shown, a balance weight being provided to secure an automatic release. The lever is so balanced that it requires but very little pull upon it to cut tubes of any size.

The rollers on which the tubes revolve are arranged so they can be brought close together or spread apart quickly to the proper distance for taking care of the various sizes of tubes or pipe. For reaming out the slight burr from the inside of the tube, which is sometimes caused by the cutting wheel, a fluted reamer is provided and attached to the end of the shaft as shown in the illustration. This reamer will ream tubes up to and including 3 inches in diameter. A larger reamer for tubes of greater diameter can be furnished and attached to the opposite end of the shaft just outside of the end bearing box. The machine is practically noiseless in operation and weighs approximately 825 pounds.

ARBOR FOR SHELL TOOLS.

A new arbor for shell tools is about to be placed on the market by the Cleveland Twist Drill Company, of Cleveland, Ohio. The essential difference between this patent arbor and the regular type is that it is equipped with an adjustable collar provided with integral keys which slide in longitudinal keyways in the arbor. The arbor is also threaded for a short distance to receive an adjusting nut which bears on the collar. The collar engages the shell reamers in the usual way.

Perhaps the chief advantage of the new arbor is the quickness and ease with which it releases the shell tool, no matter how tightly it may have become jammed on the arbor; a turn or two of the adjusting nut is all that is required, with no necessity for removing the arbor from the spindle and no excuse for the vise and hammer methods which often cause considerable damage. Another decided advantage is the fact that the collar can always be set so as to allow the shell tool to fit snugly on the arbor, and yet fully engage the collar keys with its slots.



ARBOR FOR SHELL TOOLS—CLEVELAND TWIST DRILL COMPANY.

PERSONALS.

Edward Wees has been appointed general foreman of the Ann Arbor Railroad at Frankfort, Mich.

G. R. West has been appointed general foreman of the Detroit, Toledo & Ironton at Springfield, Ohio.

J. T. Andrus has been appointed purchasing agent of the North Coast Railroad, with office at Spokane, Wash.

J. E. Mourno has been appointed assistant air-brake instructor of the Chicago, Rock Island & Pacific, with office at Chicago.

John D. Conway, secretary of the Railway Supply Manufacturers' Association, has changed his address to 313 Sixth avenue, Pittsburgh, Pa.

W. J. Davis has been appointed general foreman of the Detroit, Toledo & Ironton at Ironton, Ohio, vice J. H. Hott, resigned.

A. L. Roberts has been appointed mechanical engineer of the Lehigh Valley Railroad Company, with office at South Bethlehem, Pa.

Paul C. Withrow has been appointed mechanical engineer of the Denver & Rio Grande R. R., with office at Burnham station, Denver, Colo.

L. Fisher has been appointed master mechanic of the Fourth district, Central division, of the Canadian Pacific, with office at Winnipeg, Man.

R. P. Blake has been appointed master mechanic of the Montana division of the Northern Pacific Railway, with headquarters at Livingston, Mont.

Frederick N. Pease, assistant chemist of the Pennsylvania Railroad, at Altoona, Pa., has been appointed chemist, succeeding Dr. Charles B. Dudley, deceased.

J. H. Palmer has been appointed purchasing agent of the Georgia, Southern & Florida, with office at Macon, Ga., succeeding W. P. Hopper, promoted.

M. A. Craig has been appointed foreman of the Detroit, Toledo & Ironton at Lima, Ohio, vice G. B. Sollars, who has been assigned to other duties.

J. Murrin has been appointed superintendent of locomotive shops of the Chicago & North Western, with office at Chicago, succeeding Oscar Otto, resigned.

H. E. Smith has been appointed master car-builder of the Chicago & Alton at Bloomington, Ill. He was formerly with the New York Central at Albany, N. Y.

C. M. Hoffman has been appointed master mechanic of the Denver & Rio Grande, with office at Grand Junction, Colo., succeeding F. B. Mahoney, resigned.

John Hill, master mechanic and master car builder of the Minneapolis & St. Louis at Minneapolis, Minn., has been appointed master mechanic of both the Eastern and Western divisions, with office at Minneapolis.

H. P. Johns, chief draftsman of the St. Louis & San Francisco at Springfield, Mo., has been appointed mechanical engineer, with office at Springfield, Mo.

Robert W. Colville, master mechanic of the Galesburg division of the Chicago, Burlington & Quincy, was killed at Galesburg, Ill., December 28, by a locomotive.

W. J. Bennett has been appointed master mechanic of the Utah lines of the Denver & Rio Grande, with office at Salt Lake City, Utah, succeeding A. H. Powell, resigned.

J. A. Hannigan, general foreman of the Detroit, Toledo & Ironton at Springfield, Ohio, has been appointed to the same office at Jackson, Ohio, to succeed H. F. Martyr, resigned.

H. C. Stevens, assistant to the general storekeeper of the Atchison, Topeka & Santa Fe at Topeka, Kan., has been appointed supervisor of stores of the National Railways of Mexico.

R. S. Miller, general foreman car department of the New York, Chicago & St. Louis, at Cleveland, Ohio, has been appointed master car builder and his former title has been abolished.

D. B. Sebastian has been appointed acting fuel agent of the Chicago, Rock Island & Pacific, with office at Chicago, succeeding Eugene McAuliffe, general fuel agent, resigned. The title of general fuel agent is abolished.

C. S. White has been appointed motive power inspector of the Pennsylvania Lines west of Pittsburgh, Southwest system, with office at Columbus, Ohio, succeeding W. H. Holbrook, transferred.

C. E. Chambers, acting superintendent of motive power of the Central of New Jersey at Jersey City, N. J., has been appointed superintendent of motive power, with office at Jersey City.

O. S. Jackson has been appointed master mechanic of the Chicago, Indianapolis & Louisville, with office at Lafayette, Ind. W. J. Bennett, assistant superintendent of motive power, having resigned to accept service elsewhere, that office is abolished.

J. T. Langley, of Portland, Ore., for a number of years master mechanic for the Oregon division of the Oregon R. R. & Navigation Co., has been appointed master mechanic and an assistant general manager of the Oregon & Washington, at Seattle.

C. E. Allen, master mechanic of the Montana division of the Northern Pacific Railway, with headquarters at Livingston, Mont., has been appointed general master mechanic of the Yellowstone, Montana and Rocky Mountain divisions, with headquarters at Livingston.

Eugene McAuliffe, general fuel agent of the Rock Island-'Frisco lines at Chicago, has resigned from the Rock Island and has been appointed general fuel agent of the St. Louis & San Francisco, the Chicago & Eastern Illinois and the Evansville & Terre Haute, with office at Chicago.

C. M. Byrd has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe Coast Lines, with jurisdiction over the second district of the Albuquerque division, with office at Winslow, Ariz., and will perform such duties as are assigned to him by the master mechanic of the third district.

B. T. Jellison has been appointed purchasing agent of the Chesapeake & Ohio, with office at Richmond, Va., reporting to the vice-president and general manager, succeeding W. F. La Bonta, who will perform the duties of fuel agent. The general storekeeper will report to the purchasing agent.

J. E. O'Brien has been appointed superintendent of motive power of the Western Pacific Railway Company, with headquarters at San Francisco, Cal. Mr. O'Brien was graduated from the mechanical engineering department of the University of Minnesota in 1898. He entered the service of the Northern Pacific Railway as a special apprentice and has had a very thorough training in mechanical department affairs, having at various times been foreman, master mechanic, assistant shop superintendent, engineer of tests and mechanical engineer of that road.

J. J. Ellis, formerly superintendent of motive power and machinery of the Chicago, St. Paul, Minneapolis & Omaha, died at Manchester, Eng., December 14. Mr. Ellis retired from the service of the Omaha road January 15, having reached his seventieth year, which made him eligible for a pension. In May he left on one of his periodical trips to England, expecting to return to his home at St. Paul, Minn., in the fall. Mr. Ellis was born near Leeds, Yorkshire, Eng. He entered the service of the Omaha road in 1877, and worked continuously with the company until his retirement. He was foreman of the shops at Hudson, Wis. He was promoted to St. Paul as general foreman in 1882, when the shops were moved there. He became master mechanic shortly after that time, and was promoted to superintendent of motive power and machinery in the nineties. Mr. Ellis was prominently identified with the civic affairs of St. Paul several years ago. He was a member of the board of education in the eighties and took an active part in political matters. He is survived by a widow, now in England.

Alfred P. Prendergast, assistant master mechanic at the Mt. Clare shops of the Baltimore & Ohio, at Baltimore, Md., has been appointed master mechanic, succeeding C. T. Turner, retired, after 47 years' service in the same shops. Mr. Prendergast entered the service of the Baltimore & Ohio as an apprentice in 1885 at Wheeling, W. Va., and after completing his apprenticeship he was engaged in the steel industry in the Pittsburgh and Youngstown districts. Several years later he returned to the Baltimore & Ohio as gang foreman at Benwood, W. Va., and then became machine shop foreman at Cumberland, Md., where he also served as roundhouse foreman. He was later made general foreman of locomotive and car repairs and then promoted to division master mechanic at Grafton. Two years later he was transferred to the Baltimore and Philadelphia divisions as master mechanic, with office at Riverside, Baltimore, leaving that position two years later to go to the Mt. Clare shops at Baltimore, as assistant master mechanic, which position he held at the time of his recent appointment.

C. T. Turner, for over six years master mechanic of the Mt. Clare Shops of the Baltimore & Ohio Railroad, has retired. Mr. Turner served his four years' apprenticeship from 1864 to 1867, inclusive; after working but little over a year as a journeyman machinist his ability was recognized and he was promoted in September, 1868, to assistant foreman, which position he held until December, 1874, when he was made machine shop foreman. In 1887 he was promoted to the position of general foreman of the shops. In June, 1903, his faithful services to the company were rewarded by making him master mechanic of the large system shops located at Mt. Clare, Baltimore, where there have been employed at different periods from 1,500 to 3,000 men. Mr. Turner was a bachelor, having ever since early boyhood cared for his mother, who was left a widow with a large family to raise; at the age of thirteen the responsibilities of caring for the family rested upon him, and he has taken care of them ever since. Mr. Turner is one of those sterling characters of whom men feel confident that in obtaining a decision from him on any of the questions of life they will receive impartial and equitable consideration. He will enjoy his remaining days in providing for the pleasures of his only remaining sister, who has been the home keeper of the family, and who has assisted him always in providing for the home; he feels that the time has come when he will have ample opportunity to devote to her enough time to afford those pleasures of life which business cares have heretofore prevented.

C. J. Morrison has resigned his position with the Emerson Company to engage in efficiency engineering on his own behalf. His office is at 52 East 19th street, New York City. Mr. Morrison was graduated from the mechanical engineering department of Cornell University in 1901. He took a position with the Northern Pacific Railway as a special apprentice and was with them in this capacity, and as a material inspector, until December, 1903, when he went with the Atchison, Topeka & Santa Fe Railway as a machinist. Several months later he was detailed as an assistant to Harrington Emerson, who had installed and was in charge of the betterment work in the mechanical department on that road. In this capacity he had charge of improving the conditions of the belting, with splendid results, as noted on page 455 of our December, 1906, issue. He was also engaged in making the shop dispatching schedules and in working out the surcharge problem; his articles in the *American Engineer* on these subjects during 1906 attracted a great deal of attention and undoubtedly were instrumental in doing much good. While acting as material supervisor, at the Topeka shops, the material cost for engines was reduced 25 per cent. Mr. Morrison was also very successful in the capacity of general erecting foreman at the Topeka shops. Later as standardizing engineer of the Santa Fe system he completed the work of the standardization of tools and machinery begun by Mr. Jacobs and made a good start toward the standardization of locomotive parts. In June, 1909, he resigned his position on the Santa Fe to become associated with the Emerson Company, "efficiency engineers," and in this capacity made reports on a number of large plants and personally supervised the efficiency work at two large establishments. Mr. Morrison is a member of the American Society of Mechanical Engineers.

BOOK NOTES.

The "Practical Engineer" Pocket Book and Diary for 1910. 684 pages, 3½x5½ in. Cloth, 25 cents, net. Leather bound, 40 cents, net. Published by The Technical Publishing Company, Ltd., 55 Chancery Lane, London, W. C.

Considerable new information has been added to this new edition, including data on fuel testing, condensers, friction of air and water in pipes, alloys, table of properties of metals, pyrometry, suction gas producers, emery grinders, etc.

Freight Transportation on Trolley Lines. By Chas. S. Pease. 62 pages, 5 x 7½ in., cloth. Price, $1. Published by the McGraw-Hill Book Company, 239 W. 39th street, New York City.

The author has gone into the question quite fully in a general way as to just how to build up a profitable freight business in connection with a trolley system. It is not intended to be a detail study, but is more in the line of a statement of the general conditions which will be encountered and how to handle them.

Technical Dictionary in Six Languages.

Volume V, Railway Construction and Operation, 870 pages, about 1,900 illustrations. Price, $4.00.

Volume VI, Railway Rolling Stock, 796 pages, about 2,100 illustrations. Price, $3.00.

The information in both of these volumes was compiled by August Boshart and edited by Alfred Schlomann. Published by the McGraw-Hill Book Company, New York City.

These two volumes are the latest ones to be issued in the series of illustrated technical dictionaries in six languages—English, German, French, Italian, Spanish and Russian. The four volumes previously issued are: Vol. I, Machine Details and Tools; Vol. II, Electrical Engineering; Vol. III, Boilers, Steam Engines and Turbines; Vol. IV, Internal Combustion Engines.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

No Climbing.—This is the title of a circular issued by the L. M. Booth Company, 136 Liberty street, New York City, briefly describing the Type "F" Booth water softener.

Jeffrey Booklets.—Wire cable conveyors is the subject of Booklet No. 33 and standard elevator buckets the subject of Booklet No. 34, issued by The Jeffrey Mfg. Co., Columbus, Ohio. These are 3½ by 6 in. in size and are clearly printed in small type and profusely illustrated.

Belt Engineering.—*Phoenix*, a journal devoted to belt engineering, published by the New York Leather Belting Company, 51 Beekman street, New York City, has been enlarged and greatly improved. Sample copies will be furnished to those interested without charge.

Ferroinclave.—An attractively arranged catalog from The Brown Hoisting Machinery Company, Cleveland, Ohio, considers the adaptability and the advantages of Ferroinclave for roofing, siding, flooring, stairways, cornices and mouldings, water tanks and bins.

How 4 Cars of Coal Did the Work of 5.—A booklet under this title from the H. W. Johns-Manville Co., 100 William street, New York City, forcibly emphasizes the value of the use of Asbestos-Sponge Felted Covering for pipes and Vitribestos Boiler Covering for boilers.

Electric Mine Locomotives.—Bulletin No. 17 from The Jeffrey Manufacturing Company, Columbus, Ohio, describes the electric mine locomotives manufactured by them. It contains 66 pages, is 8 by 10 in. in size, and is thoroughly illustrated with half-tone views showing the different types of these locomotives.

Cutting and Welding Metals.—The American Oxhydric Company, Milwaukee, Wis., has issued a booklet describing the oxhydric process for cutting and welding metals. A number of typical applications of the process are illustrated and tables are given showing the consumption of gas and the time required for cutting and welding different thicknesses of metal.

An Exhaust Steam Turbine Installation.—The statement that with no additional steam the net output of a non-condensing engine plant may be increased 75 per cent. by exhaust-steam turbines cannot fail to result in more than a passing interest. A bulletin (No. 4712) from the General Electric Company takes up the subject in considerable detail and is, in fact, a reprint of an article in *Power and The Engineer*. It contains, also, an article entitled "Increasing the Output of Steam Plants," reprinted from the *Textile Manufacturing Journal*, and some notes on the low pressure turbine.

Variable Release Air Brake Equipment.—The rapid extension of the electrification of steam railroad lines and the heavier service demanded on many electric roads requiring the operation of long trains, have necessitated radical improvements in automatic air equipments to adapt them to the higher schedule speeds, shorter headways and more nearly accurate stops in electric service. The General Electric Company in Bulletin No. 4703-A describes its Variable Release Air Brake Equipment, which eliminates the defects usually found in the standard automatic air brake equipment for electric service.

Mallet Articulated Compound Locomotives.—This is the title of the first of a series of bulletins which the American Locomotive Company, 30 Church street, New York City, expects to issue monthly, and which will treat of various subjects of interest both from an engineering and operating standpoint, and as descriptive of the development of American locomotive design. The bulletin, designated as No. 1000, contains 12 pages, 8 by 10 inches in size. A brief description of the Mallet compound and its advantages and some suggestions as to the service for which it is adapted, is followed by illustrations of a number of different designs of this type that have been built by the American Locomotive Company for roads in this country and abroad. Each one of these locomotives is illustrated by a half-tone illustration and a line drawing giving the general dimensions. These are accompanied by tables giving the general specifications and data as to the hauling capacity under different conditions.

Graphite Engine Front Finish.—The ordinary and usual treatment of locomotive front ends has a number of unsatisfactory features. It requires frequent renewal, which means not only cost of material, but also cost of labor. Some of the material used is volatile, and when the engine is running and the front end becomes hot, offensive fumes come back to the cab. In aggravated cases these fumes fill the eyes of the engineer, almost blinding him for the moment, and making it difficult to see the signals. For engine front ends The Joseph Dixon Crucible Company, Jersey City, N. J., recommend their Graphite Engine Front Finish, which is said to give a service of from six to nine weeks at each application and provides an attractive coating. The value of this finish is due chiefly to the flake graphite which forms its base. It is unaffected by heat or cold and has, in addition, durable polishing properties. The Dixon Company has recently issued a circular describing this engine front finish.

Gasoline Electric Plants for Lighting and Power.—This is the title of an attractive publication, No. 4707, issued by the General Electric Company, which is of interest to those contemplating the installation of a small or isolated plant, not within reach of the distributing circuit of a central station. The pamphlet illustrates and describes complete generating units consisting of a direct current generator mounted on the shaft of a gas engine.

Curve-Drawing Ammeters and Voltmeters.—In Bulletin No. 4706, recently issued by the General Electric Company, is illustrated and described the company's type CR curve-drawing ammeters and voltmeters. This type of instrument gives a clear, permanent record of the characteristics of the electric circuit to which it is applied, and will be found of value in locating trouble with electrical apparatus, in proving the efficiency of machines and workmen, especially where the individual drive system has been adopted, and in determining the correct size and style of the new machine. This instrument is suitable for use on either alternating or direct current.

Fuel Economizers and Air Heaters.—Catalog No. 150 from the B. F. Sturtevant Company, Hyde Park, Mass., is most attractively arranged, and thoroughly and clearly discusses the advantages and the design and construction of the Sturtevant fuel economizers and air heaters. Carefully prepared illustrations show the operation as well as the construction of the economizers. A number of concrete examples are given showing the savings which are possible by their use. The Sturtevant new high pressure type economizer, with all joints metal-to-metal, will stand working pressures up to 500 pounds per square inch; the doing away with gasket joints eliminates chance of leakage. With the Sturtevant design of positive scraper mechanism, the scrapers cannot stick or bind, thus eliminating one of the troubles found in earlier designs of economizers.

The engineering section at the rear of the catalog contains data on the efficiency of fuels, the properties of saturated steam, the percentage of saving effected per degree increase in feed water, the percentage of saving effected by heating feed water from initial to final temperature, and the influence of temperature upon chimney draft.

Calendars have been received from the Buda Foundry & Manufacturing Company, Harvey, Ill., the Duff Manufacturing Company, 50 Church street, New York City; John Lucas & Co., Philadelphia, Pa.; the American Wood Working Machinery Company, Rochester, N. Y., the Falls Hollow Stayholt Company, Cuyahoga Falls, Ohio; H. B. Underwood & Co., Philadelphia, Pa., and the Bettendorf Axle Company, of Bettendorf, Iowa. The latter one is especially attractive and was designed by Bruce V. Crandall, of Chicago. The calendar itself is suspended by two cords from a miniature gilded Bettendorf bolster. On each sheet is shown a large drawing of special design, reproduced in the duo-tone process. Among the drawings, which include views of methods of manufacture in the Bettendorf plant, several are to be particularly noted. The illustration on the January sheet is of a map of the United States, and falling across it is the shadow of the Bettendorf one-piece truck frame; underneath the picture are the words "Coming events cast their shadows before." The Bettendorf plant by moonlight in February shows the big plant as it stretches for nearly a mile along the Mississippi river. Another very effective picture is of the open-hearth furnace into which are being thrown the forty-one pieces of the arch-bar truck frame. At one side a moulder is pouring out the one-piece Bettendorf truck frame in the sand. For June, which is the month of the M. M. and M. C. B. conventions, the illustration is of a young lady ready to board the train for Atlantic City. In August the Bettendorf bears take their vacation. For December, Justice is represented as standing on a world holding her scales, the balance beam of which is an elongated Bettendorf truck frame. Weighing down one side is shown the Bettendorf truck, up on the other side the arch-bar truck. Underneath the picture are the words of the handwriting on the wall, "Weighed in the balance and found wanting."

A handsome calendar has been received from The American Tool Works Company; also a loose leaf desk calendar from the Flannery Bolt Company of Pittsburgh.

NOTES

W. N. Best.—The W. N. Best American Calorific Company has retired from business and Mr. Best is personally manufacturing and selling the oil burners, regulating cocks and various types of furnaces invented by him. His office is at 11 Broadway, New York City.

Rockwell Furnace Company.—J. W. Coyle, who was connected with the Best American Calorific Company, is now with the Rockwell Furnace Company, making a specialty of oil and gas furnaces for railroad work. Mr. Coyle was formerly master blacksmith for the "Lehigh" at Wilkes-Barre, and later in charge of the drop hammer and machine department at the forge shops of the "Reading" at Reading, Pa.

The Watson-Stillman Company.—Several additions have been made to the sales department to handle the increasing business in hydraulic tools and turbine pumps. Edwin Stillman has entered this department, and is assisting in taking care of customers in New York State, while all southern railroad business is now in charge of Frank C. Clark. The more direct representation that has become necessary in the Orient will be in the hands of F. W. Horn, the well known machinery importer of Yokohama, Japan.

AN EXPERIMENTAL MALLET ARTICULATED LOCOMOTIVE*

Canadian Pacific Railway.

G. I. Evans.

A Mallet articulated locomotive was designed and constructed by the Canadian Pacific Railway, under the direction of H. H. Vaughan, assistant to the vice-president, during 1909, which embodied some very unique and original features.

Construction-General.

Reference to the general drawings of the locomotive shows that there is considerable difference between this design and other Mallet locomotives recently put into service on American railways. The most striking difference is in the arrangement of the cylinders, the shortness of the front bumper or footplate, the position of the superheater and the absence of front and back guiding trucks. This arrangement of cylinders, whereby the two pairs are brought together near the center of the locomotive, permits of an extremely simple pipe arrangement, cutting out a number of packed expansion joints, every one of which is a continual source of trouble through leakage. The removal of the cylinders from the front also permits of shortening the over-all length of the locomotive; as locomotives of this type are very long every foot possible must be saved to permit of their being taken into existing engine houses.

Provision has been made for changing the piston packing rings by simply removing the front cylinder heads, disconnecting the main rod from the crosshead and pushing the piston out into the space between the two cylinders; the piston valves have also been taken care of in a similar manner so there can be no objection to this arrangement on account of inaccessibility.

Boiler and Superheater.

The boiler is of the wagon top type, as shown by Fig. 2, is radially stayed and has an unusually small front ring and smokebox; there are three separate compartments in the barrel, the front of which is practically a feed water heater and owing to its small diameter is full of water all the time. The injectors discharge into this compartment which is connected to the boiler proper by two equalizing pipes 4 in. in diameter, one of which is located on the side center line and the other on the top.

The second or middle compartment is for the superheater which consists of double loops of 1¼ in. seamless steel tubing dropped down into the path of the hot gases from the firebox. There are 69 of these superheater elements; one end of each connects to the saturated steam header which takes steam from the boiler, and the other connects to and discharges into the superheater header which is connected direct to the high pressure cylinders. When the locomotive was first turned out the superheater was connected to the low pressure cylinders, but as a result of tests made subsequently it was changed as described. The reasons for this are explained in another part of this article. Two ¾ in. blower pipes are so located as to blow jets of steam diagonally across the superheater compartment, through the tubes, to bring down any soot which may collect.

There is no steam in the superheater pipes when the throttle is closed, but no cases of burning out have developed after about four months' service; nor is any trouble anticipated as this condition applies, although to a lesser degree, to other types of superheaters that are giving good service. The superheater pipes are secured to the headers by union nuts and are readily removable for repairs, one element at a time, through the opening at the top of the boiler which is closed by a flanged steel door. If necessary the complete superheater, header and tubes may be lifted out bodily.

The back compartment is the boiler proper, or steam generating section, and the construction is similar to ordinary boilers except that the radii at the corners of the firebox, both inside and outside, are larger than usual. This has been done to decrease the rigidity of the sheets, which, it is believed, is largely responsible for staybolt breakage on the end rows. There are four flue sheets in the boiler and two sets of flues; the front set is 96 in. long and the back 109 in., with a 63 in. superheater compartment between, and although cleaning holes have been applied underneath, it is seldom found necessary to use them, all cinders being carried through by the action of the draft.

As before stated, the front section of the boiler is really a feed water heater and has 281 tubes 2 in. O. D. and 12 tubes 2¼ in. O. D., giving 1,230 square feet of heating surface, leaving 1,555 square feet in the steam generating section (tubes and firebox). The measure of the steaming capacity of this locomotive as expressed by the formula, $\frac{\text{T. P. (max.)}}{\text{H. S. (total)}} \times$ dia. drivers, is shown in comparison with others of similar type in the following table; as the Canadian Pacific locomotive has a superheater the equivalent heating surface has been used:—

Road.	Builder.	$\frac{\text{T. P. (Max.)}}{\text{H. S. (Total)}} \times$ dia. drivers.
Can. Pac	Can. Pac.	975
B. & O.	Am. Loco. Co.	715
Gt. Nor. (Road)	Bald. Loco. Wks.	813
Gt. Nor. (Pusher)	Bald. Loco. Wks.	690
Erie	Am. Loco. Co.	910
D. N. W. & P.	Am. Loco. Co.	775
Cen. Brazil	Am. Loco. Co.	915

In using this factor in comparisons it must be borne in mind that the lower its value the greater will be the capacity of the boiler as a steam generator, and, from the above table, it might seem that the Canadian Pacific locomotive would not steam satisfactorily; this, however, is not the case as an inspection of the boiler pressures in Figs. 9 and 11 will show.

The injector check valve is located on the top center line of the boiler and consists of a cast iron body with connections for the right and left-hand injectors and a third connection suitable for a pipe or hose coupling which is used for filling or blowing off the boiler.

Throttle, Steam and Exhaust Pipes.

The throttle valve is located on the top of the boiler outside and consists of an iron casting having two 5 in. steam pipe connections, one on either side; the joint to the boiler is made by a brass ball ring having an opening 12¾ in. in diameter. The throttle casting extends down through this and connects to a cast iron dry pipe which takes steam from a dome set further forward on the same course; the arrangement of this is shown clearly on the boiler drawing, Fig. 2.

Outside steam pipes lead from the throttle to the saturated header of the superheater, and steam, after passing through it, goes directly to the high pressure cylinders, also through outside pipes which are heavily lagged to prevent condensation, as are also the pipes from the throttle. This portion of the piping

* This article is furnished, by special agreement, jointly to the American Engineer and Railroad Journal and the Canadian Railway Club.

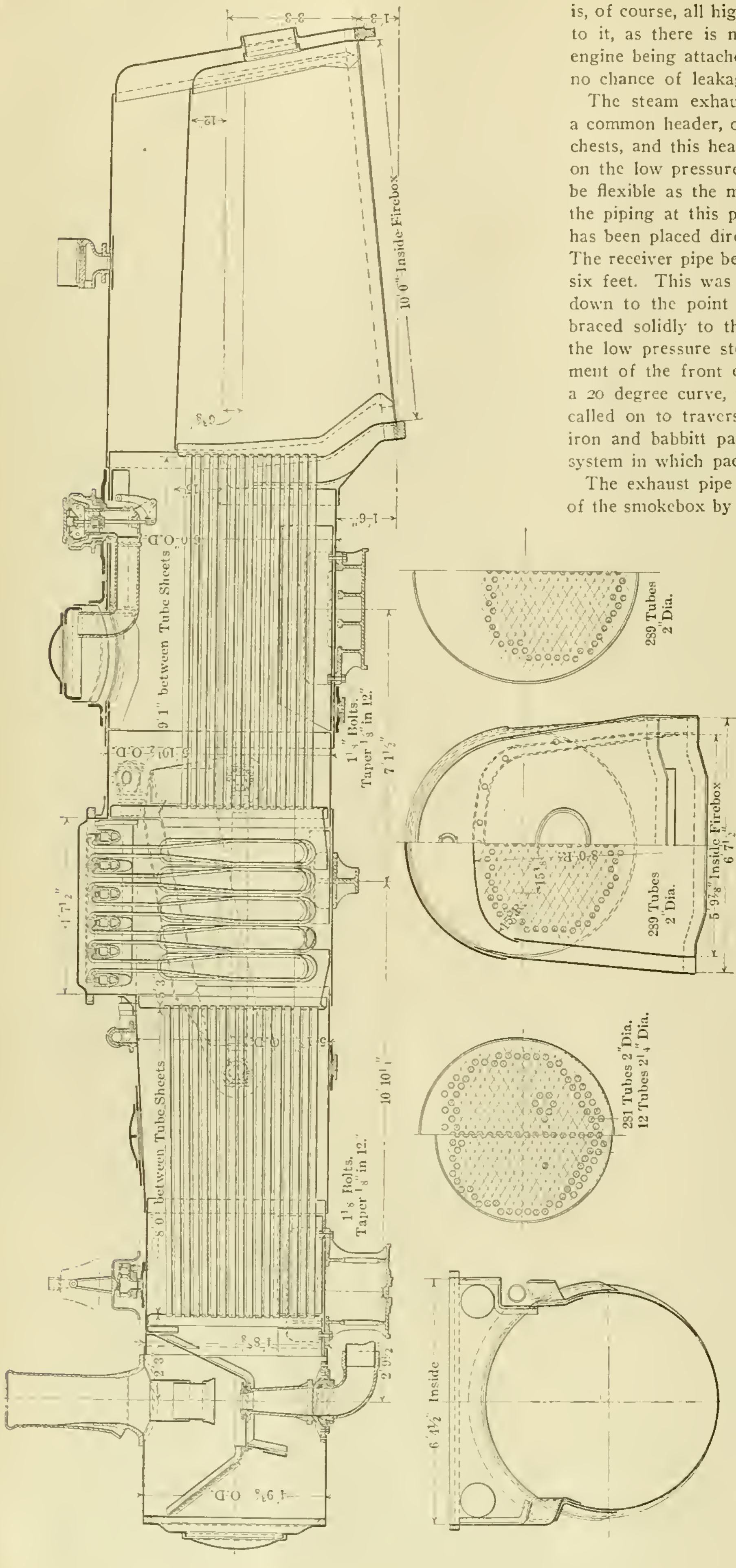


FIG. 3.—BOILER AND SUPERHEATER, MALLET COMPOUND LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.

is, of course, all high pressure, but no special importance attaches to it, as there is no movement in the pipes, the high pressure engine being attached rigidly to the boiler. There is, therefore, no chance of leakage if the joints are properly made.

The steam exhausts from both high pressure cylinders into a common header, or receiver, bolted over the ends of the steam chests, and this header connects by a 7 in. pipe to a similar one on the low pressure cylinders, which connection, however, must be flexible as the movement of the front truck begins to affect the piping at this point. To minimize its effect, the connection has been placed directly over the pivot point of the front truck. The receiver pipe between the two headers extends upward about six feet. This was done to give sufficient volume, and this pipe down to the point where it enters the low pressure header is braced solidly to the boiler and the connection which bolts to the low pressure steam chest rotates about it due to the movement of the front engine. This rotation is about 5 degrees on a 20 degree curve, which is the greatest the locomotive will be called on to traverse. The joint is packed with alternate cast iron and babbitt packing rings and is the only one in the pipe system in which packing is used.

The exhaust pipe connects to the cylinder and the under side of the smokebox by ball joints and both ends have a small rotary movement, but, as the angular movement is only 2 ft. 34 in. on a 20° curve, the extension between the connections is only ⅜ in., which is taken up by the sliding of the pipe flanges on the flat faces of the ball rings. The flanges are held to their seats on the ball rings by 10 springs of 200 lbs. capacity each, or a total of 2,000 lbs. The extension due to the truck movement being provided for in this way, the use of a packed expansion joint is unnecessary.

The arrangement of this portion of the piping, which may be called the low pressure system, is shown by Fig. 3; the dotted lines show the movements of the pipe on a 20° curve and the diagram underneath shows the movements of the pipes as they would have been if the low pressure cylinders were at the front of the engine. A comparison of the two arrangements shows that with the cylinders at the front the angular movement of the exhaust pipes would be 15° 19' and its extension 1⅝ in., which would necessitate the use of two universal ball joints with packing and a packed expansion joint instead of the two simple ball rings which are sufficient to take up both the rotary movement and extension. The receiver pipe movement would be the same provided the connection to the high pressure cylinders was directly over, or close to the frame connection pin. This pipe is usually given flexibility by a packed universal ball joint and a packed expansion joint.

From the above it will be seen that with the low pressure cylinders at the front and following the usual pipe construction, five packed joints would have been used, but with the arrangement adopted there is only one packed joint and two ball rings.

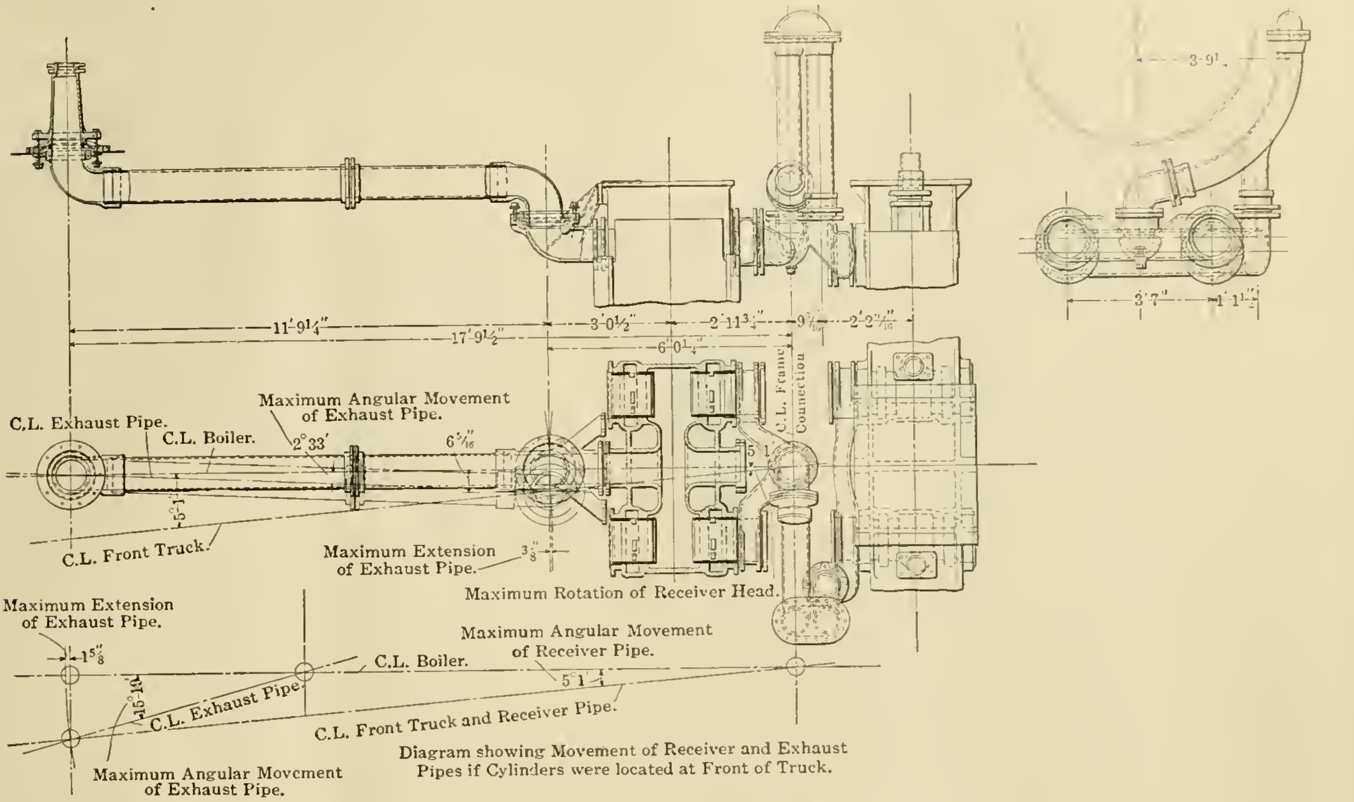


FIG. 3.—STEAM, EXHAUST AND RECEIVER PIPES. DOTTED LINES SHOW POSITION ON A 20° CURVE.

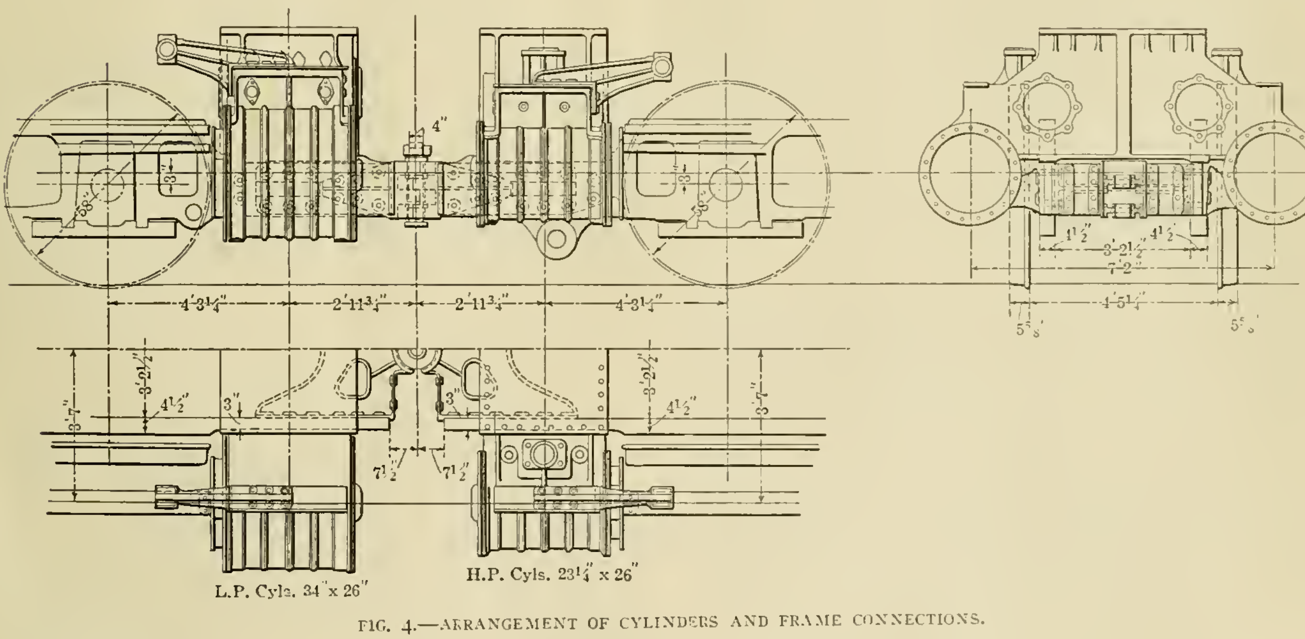


FIG. 4.—ARRANGEMENT OF CYLINDERS AND FRAME CONNECTIONS.

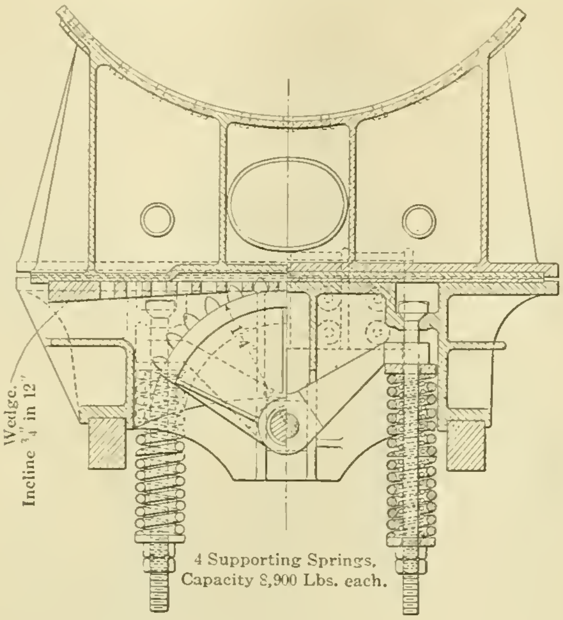
Cylinders, Valves and Valve Motion.

The cylinders are of the piston valve type with inside admission on the high pressure and outside on the low pressure which permits of the most satisfactory arrangement of steam pipes. The diameters are: high pressure, 23¼ in. by 26 in. stroke; low pressure, 34 in. by 26 in. stroke; all four are cast separately without saddles and are bolted together by vertical flanges in the usual manner. The high pressure cylinders have a cast steel saddle, which is common to both cylinders and which bolts rigidly to them and to the boiler. This connection to the boiler is a very important one, the barrel being under pressure at this point and the saddle is secured with 1¼ in. bolts, having a taper of 1/16 in. in 12 in., driven into holes reamed from the pressure side.

The low pressure cylinders have no saddle, as there is a movement between the boiler and truck at this point. A small steadying casting has, however, been applied with slides across the flat surface on the top of the cylinders, but no weight is transmitted to the truck by it.

The main frames are slabbed to a section 15 in. deep by 3 in. wide at the cylinder fits and are braced laterally by the frame connection castings which join the engines together. The arrangement of the cylinders and their fastening is shown in Fig. 4.

Walschaert valve motion is used; the design varies but slightly from that used on other Canadian Pacific locomotives, except in



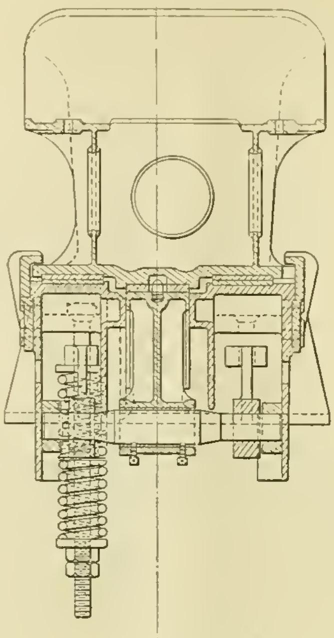
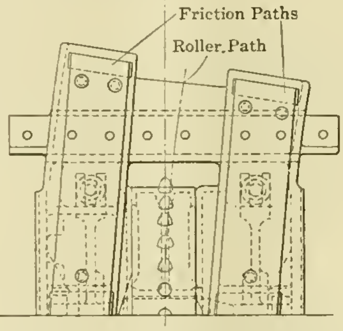


FIG. 6.—BOILER BEARING AND GUIDING DEVICE.



the radius bar lifting link on the low pressure engine which, of course, must have flexible connections to permit of movement between the boiler, to which the reversing arm is attached, and the truck. It must also be made as long as possible, as, when the locomotive is rounding a sharp curve the boiler will swing about 9 in. off the center line of the truck at this point, and the angle taken by the lifting link causes the radius bar to raise in the radius link, shortening the travel of the valve when the engine is in forward gear and lengthening it when in backward, the radius bar being down for forward and up for backward gear. This applies to all Mallet locomotives having the radius bar suspension arranged in this manner, but is comparatively unimportant if sufficient clearance is allowed between the radius link and block at the top.

Provision has also been made for varying the cut-off in the low pressure cylinders independently of the high pressure; that is, the low pressure cut-off may be lengthened or shortened without affecting the high pressure.

Reference to the general drawing shows that the high pressure reverse shaft has two arms on the right-hand side; one of these is 11½ in. long and is connected to the power reverse cylinder, the stroke of which is 12 in. As the high pressure radius bar lifting arm is forged to the same shaft, the lift or fall of the radius bar is always proportional to the travel of the power reverse cylinder piston. The arm on this shaft has a slotted upper end, with a sliding block, to which the low pressure reach rod pin connects; this block is held in any desired position by means of a screw adjustment. The shortest length of the arm is 12½ in. and with the longest power piston travel of 12 in. the movement of the reach rod is $\frac{12}{11.5}$ x 12.5 or 13 in. nearly; if, by means of the screw, the reach rod block is moved up to 14 in. from the shaft the movement of the reach rod becomes $\frac{12}{11.5}$ x 14 or 14.6 in., with a consequent increase in the rise or fall of the low pressure radius bar, which will increase the travel of the valve.

A simple form of power reverse gear is used, consisting of a 6 in. steam cylinder with its piston rod connected to the reach rod shaft, as described above; rapid movement is prevented by an oil dash pot, the piston of which is connected to the same rod as the piston of the power cylinder.

Frames, Spring-Rigging and Weight-Distribution.

The frames on each engine are in one piece and are slabbed for the cylinder fits and for the front bumper and back footplate which makes a very simple arrangement, there being no frame splices to break or get loose. At the same time it gives a stronger cylinder fastening; the sections of the top and bottom rails of these frames are 4½ in. wide by 4½ in. deep, top, and 4½ in. wide by 3 in. deep, bottom, on both frames. Owing to the rather unusual conditions of weight distribution, the design was gone into very carefully and the sections not only checked against the piston thrust, which is usually all that is considered, but against the weights carried by the frames. The bending moment and shearing forces for the front engine are shown by Fig. 5; these

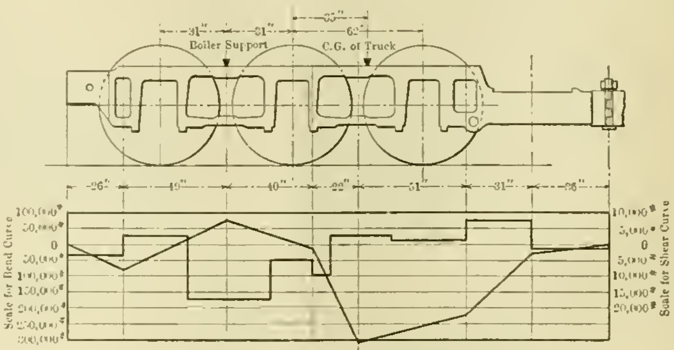


FIG. 5.—DIAGRAM OF BENDING MOMENT AND SHEARING FORCES.

have been worked out considering the frame as a beam supported at four points (where it rests on the springs), the re-action being equal to the sum of the loads supported by the springs.

This diagram shows that the proportion of the boiler weight carried by the front engine is concentrated at a point midway between the first and second wheels or 31 in. ahead of the middle wheel, and as this is the only point on the front truck at which the boiler is supported the weight must be such that its moment about the center of the truck will equal the moment of the weight of the front truck itself, acting at the distance its center of grav-

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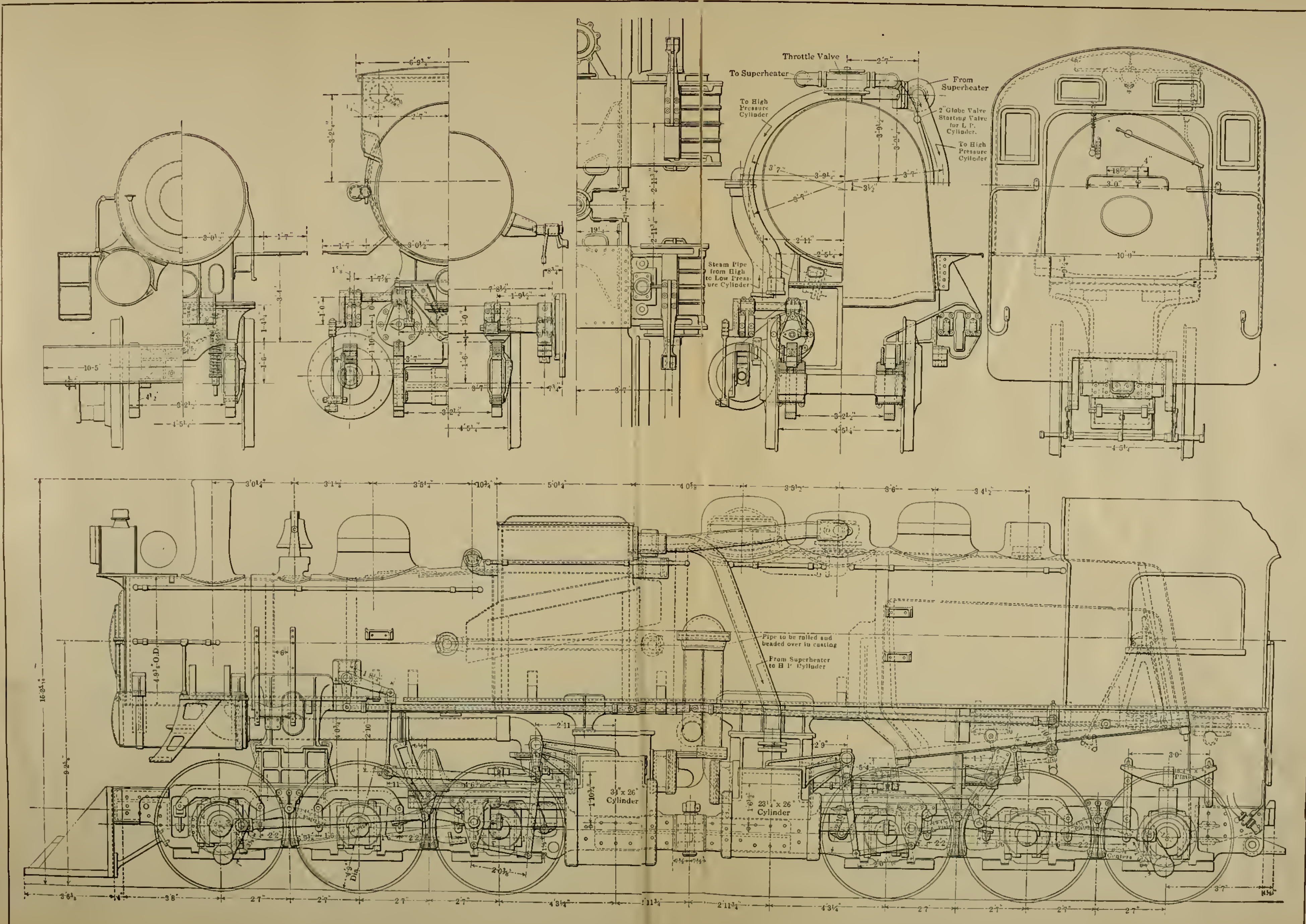


ELEVATION, SECTIONS, AND PARTIAL PLAN AT CYLINDERS OF MALLET COMPOUND (0-6-6-0) LOCOMOTIVE, CANADIAN PACIFIC RAILWAY.

ity is located in the rear of the center of the truck. On most Mallet locomotives now in service this is not the case; the actual point of support of the boiler on the frames is set forward (considering a truck with the cylinders at the front) of the virtual point sufficiently far to make the moment of the truck weight considerably greater; this is done to prevent rocking in a longitudinal direction, and, of course, tends to allow the truck to drop at the front, to correct which, a suspension bolt working on ball seats connects the lower rail of each back engine frame to the upper rails of the front engine. Any tension put on them by screwing up on the adjusting nuts pulls down on the rear end of the front engine frame correcting the effect of the center of gravity of the front system falling ahead of the center of the truck.

On the Canadian Pacific Mallet this rocking effect is checked by the frame connection castings which have jaws that interlock in such a manner as to make longitudinal rocking impossible. The arrangement of these castings and their pin connection is clearly shown by Fig. 4; the construction at the joint is very substantial. A turned pin 4 in. diameter is used, and with this arrangement of interlocking jaws the pin is put in triple shear when pulling, but for buffing shocks which are more severe it is entirely relieved and the shock is taken up by the socket joint formed by the metal around the pin on the front casting fitting into a machined pocket on the back casting.

As the extension of the exhaust pipe due to the truck movement must be taken up by the sliding of the pipe flanges on the ball rings, and as only a rotary movement has been provided for on the receiver pipe, the importance of having a solid connection for the frames of the two engines is seen.

The spring rigging is of an ordinary type; the front engine is equalized from back to front and has a cross equalizer at the front; the rear engine is also equalized through its whole length, but has no cross equalizers. The weights carried by the front and back engines are not equal but are so distributed that approximately 9,000 lbs. more weight is carried by the front than by the back. As the effect of pushing or pulling a train is to reduce the weight on the front truck and the service for which the locomotive was built calls for continued maximum tractive effort for considerable distances, it is important that the ratio of the adhesive weight to tractive power be sufficiently high to ensure the engine holding the rail. As this ratio is 4.57, which is about as low as is desirable, it will be seen that any transfer of weight from the front truck would further reduce the adhesion factor and tend to make the front engine slip.

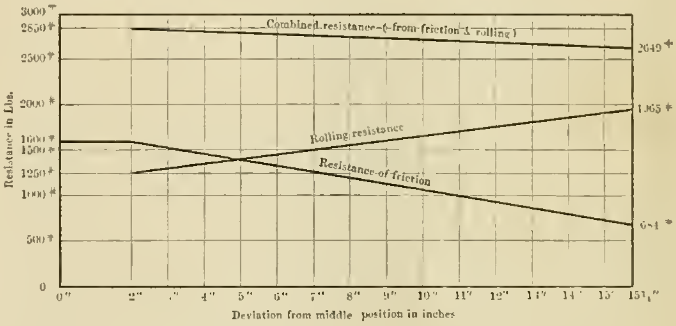
Guiding Power of the Front Engine.

The weight of the boiler, which offers the principal resistance to curving as the truck must swing laterally underneath it, is partly supported by friction plates and partly by a spring suspended roller. The arrangement of this device is shown by Fig. 6 and its action is as follows: There are two main castings, one of which is mounted on the frames and the other bolted solidly to the boiler moves with it across the frame casting. The weight of the boiler and attachments resting on the front truck at this point is 40,000 lbs., and one-half of this, or 20,000 lbs., is carried on friction plates, four of which are set on each casting forming two approximately radial paths, with an 8¾ in. space between. The total area of these plates is 834 square inches, and provision has been made for lubrication, each plate having oil grooves connecting with an oil box on the top casting; under these conditions the co-efficient of friction may be taken as .08, which gives 1,600 lbs. at starting, as the resistance due to friction; this resistance decreases slightly, as will be explained later.

In the 8¾ in. space between the two friction paths on the upper casting is the roller path, which consists of two wedge shaped blocks having an incline of ¾ in 12; these are set with their thin ends at the center line between the frames, and these ends have also been made flat for a distance of 2 in. on each side of the center.

The roller on which the inclined blocks travel is carried by two equalizers supported on springs, which in turn are carried by the bottom castings; any movement of the truck sideways, as when entering a curve, causes the inclined blocks to force the roller downward against the resistance of its supporting springs, which produces a force to pull the boiler around the curve with the truck, and relieves the leading flanges of the back engine from the excessive pressure which would otherwise result. The greater the movement of the truck sideways, the greater will be the deflection of the springs, and there will be a constantly increasing rolling resistance as indicated by the truck guiding power chart, Fig. 7, which shows the curve marked "rolling resistance" as starting at a point which corresponds with the beginning of the incline or 2 in. from the center; the resistance at this point rises immediately to 1,250 lbs. and increases to 1,965 lbs. at 15¾ in., or the maximum movement sideways.

As mentioned above, the frictional resistance decreases slightly; this is due to the reduction of weight on the friction paths as the truck moves sideways, caused by the additional weight carried by the springs, and consequently by the roller also. The decreasing frictional resistance is shown by the drop in the curve marked "frictional resistance," and begins 2 in. from the center, or the point where the roller picks up weight. The total resistance offered by the boiler to the truck moving sideways is shown by the curve marked "combined resistance." When the locomotive is entering a curve, for the first 2 in. truck movement to either side, the resistance is only that due to friction, or 1,600 lbs. When straightening out, as on leaving a curve, the inclined surfaces tend to slide the boiler back to its normal position on the center of the truck against the increasing frictional resistance, thus relieving the pressure on the flanges.



When boiler is in middle position:
Load on sliding surfaces........................ 20,000 lbs.
Load on springs........................... 20.000 lbs.
Inclination of wedge, ¾ in 12.
Coefficient of friction taken at .08.

FIG. 7.—GUIDING POWER OF FRONT TRUCK.

The resistance may be entirely altered by changing the inclination of the wedges, or the amount of rolling or frictional resistance may be varied at will by screwing up or slacking off on the roller supporting spring nuts, which has the effect of increasing the weight on the roller and decreasing the weight on the friction plates, or vice versa.

The total resistance, however, would not be materially altered unless the incline of the wedges was changed, which may easily be done by raising the boiler at the front, as the wedges are not cast solid with the top casting, but are held in pockets in it.

Tests.

As the locomotive was of an experimental nature, a number of tests were made to determine if the desired results were being obtained. These tests were not directed towards the amounts of coal and water consumed, or the economy of the machine as compared with other heavy road locomotives, but were more as a check on the design in general to show what changes would be desirable in locomotives of the same type constructed in the future.

Special attention was therefore directed towards the following:

(1) The receiver and exhaust pipes and their connections.

(2) The boiler and machinery—whether the boiler was of sufficient capacity to supply steam to the cylinders and what improvements could be made in the details of the latter.

(3) The ability of the locomotive to curve freely; that is, to

traverse curves having a radius as short as any on which it would have to operate and to do this at ordinary speeds both heading and backing on, without danger of derailing, or excessive flange wear.

(4) The ability of the locomotive to develop the calculated tractive power.

(5) The most satisfactory size of cylinders and arrangement of reheater or superheater; that is, what diameter of cylinders within the limits of 22 in. to 23¼ in. on the high pressure and 32½ in. to 34 in. on the low pressure would give the best results using either reheated steam in the low pressure or superheated in the high pressure.

Of these 1, 2 and 3 could be settled by observation of the locomotives when pulling the test trains and on a 20° curve, as well as in regular service later. Nos. 4 and 5 necessitated the use of the dynamometer car and indicators.

The locomotive was particularly adapted for experiments as to the size of cylinders and arrangement of reheater or superheater; the cylinders had bushings which would permit of varying their diameters, and the outside arrangement of steam pipes made possible the use of a reheater for the high pressure exhaust, or a superheater in direct communication with the boiler at small cost.

It was apparent from the first that the receiver and exhaust pipes would do what was expected of them, and, during the period of about 10 days when the locomotive was under test, and 3 weeks observation subsequently during the regular service, no leakage of steam developed, nor was it even necessary to tighten up on the packing gland on the receiver pipe or the bearing plates of the sliding ball rings on the exhaust pipe. Owing to its length the exhaust pipe has considerable capacity as a receiver and the exhaust is very mild, but this may be considered as an advantage, as no difficulty is experienced in maintaining full steam pressure. Some leakage developed around the taper bolts which hold the high pressure cylinder saddle to the boiler, and on future locomotives other systems of fastening will be considered.

All curves were traversed freely, both heading and backing on, and from observations made on a "Y" on which the rails were light and the curvature about 18° at one point, it was proved conclusively that the articulated locomotive did less damage and curved easier than an ordinary 2—8—0 locomotive weighing 185,000 lbs. with a rigid wheel base of 15 ft. 10 in. and a total wheel base of 24 ft. 4½ in., the pony truck having 5 in. x 8 in. three-point hangers.

The amount of flange wear after about 4,000 miles was 3/61 in. at the point of contact between the rail head and flange on the leading wheels, and 1/32 in. on other wheels. This is satisfactory service considering the crookedness of the track on which the locomotive operated, there being a large number of 10° curves; this amount of wear also compares very favorably with that on other locomotives in the same service.

The size of the cylinders on the locomotive as first turned out were 22 in. and 32½ in. x 26 in., or a ratio of 2.18, and the exhaust from the high pressure pair passed through the reheater before entering the low pressure steam chest. Three other combinations of cylinders and positions of reheater or superheater were tried, and altogether six tests were made before the final size of cylinders was determined.

A large number of indicator cards were taken and those shown by Fig. 8 are fairly representative of each test. In the "Summary of Indicator Cards" the measure of steam at cut-offs is expressed in terms of the following:

Steam at cut-off = (T. P. per lb. M. E. P. x cut-off % + T. P. per lb. M. E. P. x clearance %) x pressure at cut-off + 14.7.

Fig. 9 shows the dynamometer car record, indicated and dynamometer horse powers, speed, boiler pressures, etc., for tests 4 and 5.

In tests 1, 2 and 3, which were made under similar conditions, it was found that there was practically equal amounts of steam in each pair of cylinders and that the low pressure cylinders were developing considerably greater power than the high pressure. This condition can best be accounted for by the increased volume of steam in the receiver due to its being reheated and consequently expanded, causing excessive back pressure on the high pressure pistons, as indicated by the drop in pressure between the back pressure line on the high pressure cards and the admission line on the low pressure.

To more nearly equalize the power, it was decided to increase the diameter of the low pressure cylinders to 34 in., or a ratio of 2.38, which would have the effect of emptying the receiver more rapidly, with a consequent decrease in back pressure and rise in M. E. P. on the high pressure pistons without materially changing the amount of work done by the low pressure.

The reheater was left connected to the receiver, the lack of condensation at the cylinder cocks being very noticeable, which

SUMMARY OF INDICATOR CARDS

Test	Card	M. E. P.	H. P.	Indicated Tractive Power	Steam at Cut-Off Measure	Steam at Cut-Off %	Wor Cylinder %	Tractive Power Total	Horse Power Total
	5 HP	90	164	19500	37700		41		
1	5 LP	60	238	28500	37600	99¾	59	48000	804
	6 HP	86	157	18650	33800		43		
	6 LP	52	207	24700	32320	96	57	43350	728
	44 HP	98.5	117	21300	41000		45		
4	44 LP	50	142	26000	38750	95	55	47300	518
	46 HP	91.5	109	19800	40950		44		
	46 LP	48.5	139	25200	38600	94	56	45000	496
	2 HP	111.8	124	24200	42500		48		
5	2 LP	50.5	134	26300	37300	87½	52	50500	516
	3 HP	117.5	116	25550	44250		47½		
	3 LP	54.5	128	28200	38600	87	52½	53750	488
	9 HP	100	194	24300	48000		46		
6	9 LP	55	229	28600	40100	83¾	54	52900	846
	10 HP	99.5	193	24150	47400		45		
	10 LP	57	236	29600	40750	86	55	53750	858

For "steam at cut-off %" the largest measure in each pair of cards is taken as 100%.

Test No. 1, Cyls. 22" & 32½" x 26", Ratio 2.18, Reheater connected to L. P.
Test No. 2, Cyls. 22" & 32½" x 26", Ratio 2.18, Reheater connected to L. P.
Test No. 3, Cyls. 22" & 32½" x 26", Ratio 2.18, Reheater connected to L. P.
Test No. 4, Cyls. 22" & 34" x 26", Ratio 2.38, Reheater connected to L. P.
Test No. 5, Cyls. 22" & 34" x 26", Ratio 2.38, Superheater " to H. P.
Test No. 6, Cyls. 23¼" & 34" x 26", Ratio 2.14, Superheater " to H. P.

was a desirable feature. The maximum temperature obtained in the low pressure steam chest using reheated steam was 440°, which, with a pressure of 75 lbs., would give 120° superheat. The result of this arrangement is shown by Test No. 4 and made considerable improvement in the distribution of power, although the equalization could still be improved.

At the conclusion of this test the reheater pipes were changed to connect to the high pressure steam chest and the receiver pipe, as shown by Fig. 3, was applied. Superheated steam would thus be used in the high pressure cylinders and the exhaust would pass direct to the low pressure steam chest.

The amount of steam shown by the low pressure indicator cards in Test No. 5 now averaged about 87% of that shown by the high pressure cards, and the total amount of power as calculated from the series of indicator cards was approximately equal between the two engines.

It was next decided to try and increase the total power of the locomotive, which could still be done, as the factor of adhesion could be reduced without going below safe limits.

The most satisfactory ratio as indicated by the previous tests would have been 2.38, as shown by Test No. 5, but as the bushing had been removed from the low pressure cylinder, its diameter could not be further increased and the high pressure only was changed, its diameter being increased to 23¼ in., or a ratio of 2.14. Although the low pressure cylinder diameter could not be increased, its cut-off could be lengthened by means of the adjusting arm, previously described, without changing the cut-off in the high pressure, which would have a similar effect in reducing the back pressure on the high pressure pistons.

The results obtained with this arrangement are shown by Test No. 6, and everything considered it was the most satisfactory which had been tried; the power had been increased and the amounts developed by each engine were reasonably well balanced.

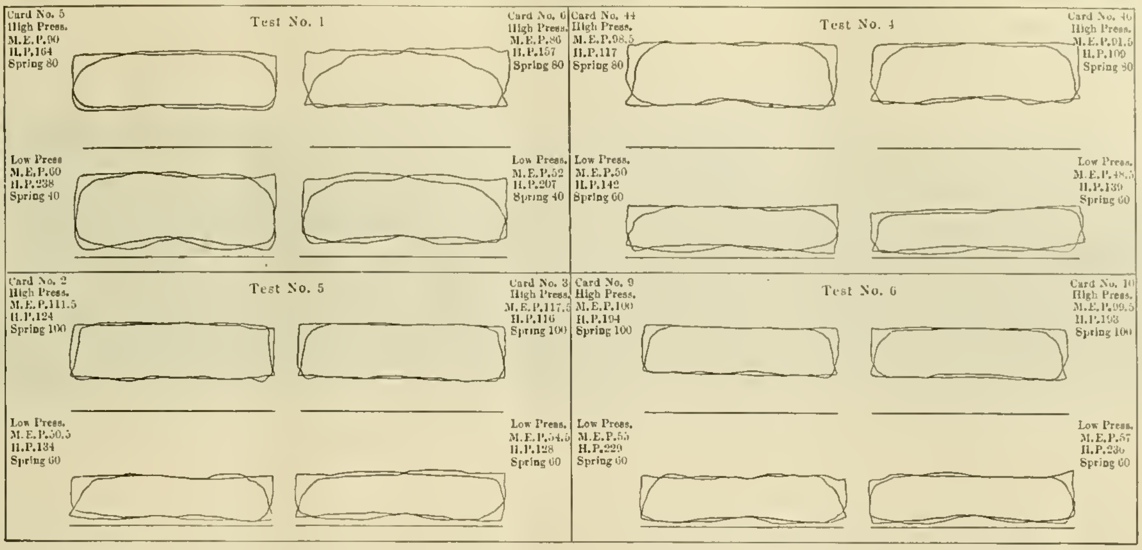


FIG. 8.—INDICATOR CARDS.

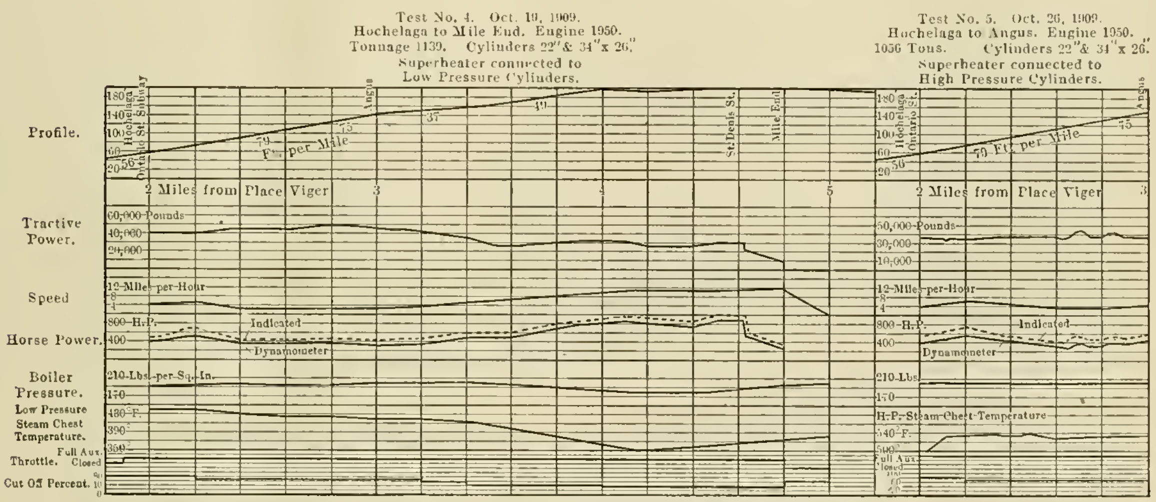


FIG. 9.—DYNAMOMETER CAR RECORD.

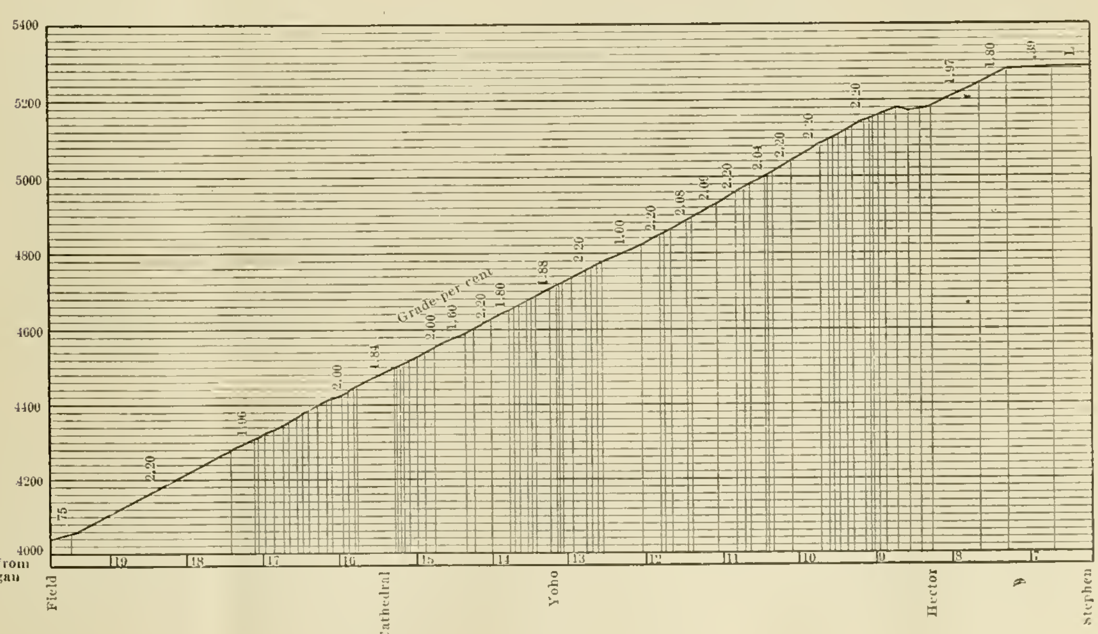
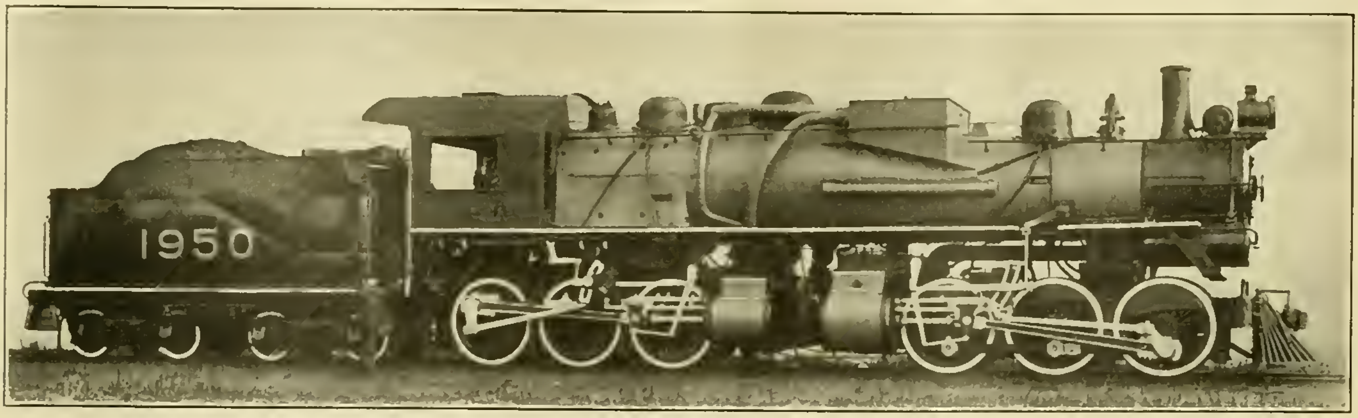


FIG. 10.—PROFILE—FIELD TO STEPHEN.



MALLET ARTICULATED LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.

The decrease in the measure of steam in the low pressure cylinders, due to the position of the superheater, is well illustrated in this test by comparing it with No. 1, in which the amounts were very nearly equal.

As the tests just described indicated that the best results would be obtained with cylinders 23¼ in. x 26 in. on the high pressure engine, and 34 in. x 26 in. on the low, and with the high pressure cylinders taking steam from the superheater, the locomotive was put into regular service in the Rocky Mountains, pushing on the grade eastward from Field to Stephen.

The profile of this section is shown by Fig. 10; the maximum grade is 2.2%, and there are two spiral tunnels of 2,890 ft. and 3,200 ft. long, having a radius of 573 ft.

The regular locomotives working on this and similar grades in the Rocky Mountains have general dimensions as follows:

Type	2—8—0
Class (Ry. Co.'s)	M—4
Cylinders	21 in. x 28 in.
Driving wheels, diameter	58 in.
Boiler pressure	200 lbs.
Weight on drivers	168,000 lbs.
Weight, total	185,000 lbs.
Tractive power	36,200 lbs.
Factor of adhesion	4.65

That used in regular service is known as "Canmore Coal," and is mined in the Rocky Mountains; it is much finer than the Dominion coal and very dusty and must be thoroughly wet down before firing, otherwise a considerable percentage goes up the stack in the form of cinders; it is rather higher in fixed carbon than the former, but the heat value is about the same.

The locomotive steamed as successfully with the "Canmore coal" as it did with the Dominion coal, although adjustments were necessary in the smokebox diaphragm and draft pipes, the diameter of the exhaust nozzle with both coals being 4¾ in.

Fig. 11 is the log of what may be considered a representative trip of the locomotive in regular service on the Field Hill, and is chiefly interesting as proving that the boiler is of ample capacity to supply steam to the cylinders; it also shows the temperatures and pressures in the high and low pressure steam chests. The maximum temperature shown in the high pressure steam chest was 540 degrees, or 153 degrees superheat. An average of a number of trips shows a temperature of 535 degrees, or 148 degrees of superheat, which is reached soon after a train is started and remains practically constant, irrespective of boiler pressure, cut-off, throttle position, or speed.

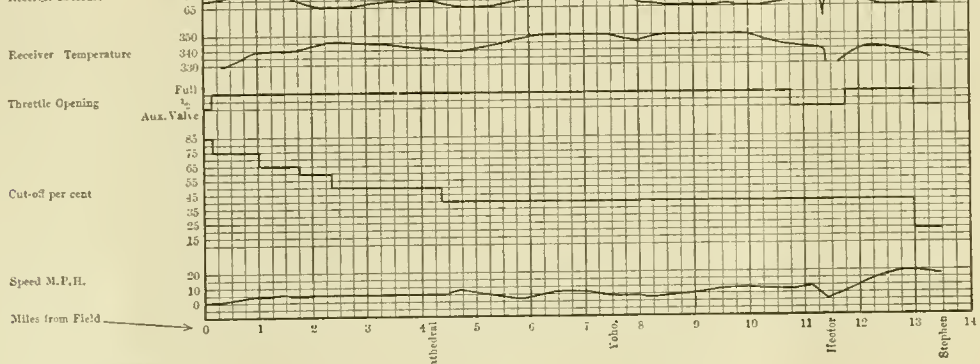


FIG. 11.—LOG OF STEAM PRESSURES AND TEMPERATURE.

Their full rating in summer is 424 tons, and on the same basis the Mallet locomotive should handle 660 tons, which it does without trouble, and has also taken up 700 tons, which may be considered the maximum tonnage for this grade.

Dominion coa was used on the tests made at Montreal; this is a friable, rather fine coal, and an average of the analyses of 25 samples gives the fixed carbon as 55.71% and the heat value 13,729 B. T. U.

The maximum temperature shown in the receiver pipe was 350 degrees, and the average was about 345 degrees, and as the pressures ranged from 60 lbs. to 75 lbs., this would give from 38 degrees to 25 degrees superheat in the receiver.

The amount of condensation in the low pressure cylinders is very small and the cylinder cocks are closed after a few revolutions, which, of course, tends to decrease the water consumption.

As the locomotive has not been in service sufficiently long, no figures are available as to the cost of maintenance, but it is to be expected that as there is practically double the amount of machinery, this will be somewhat higher than on the consolidation locomotives in the same service.

The operating costs will be slightly higher when considered on a locomotive mile basis; the same crews do the work for the same wages, but more lubricant, waste and sand must of necessity be used, and the cost of wiping and cleaning will also be higher.

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Pusher
Fuel	Bituminous Coal
Tractive power	57,400 lbs.
Weight on drivers, working order	262,000 lbs.
Weight, total in working order	262,000 lbs.
Weight of engine and tender, working order	391,000 lbs.
Wheel base, front engine	10 ft. 4 in.
Wheel base, rear engine	10 ft. 4 in.
Wheel base, total engine	35 ft. 2 in.
Wheel base, engine and tender	60 ft. 7 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.57
Tractive effort × diam. drivers ÷ equivalent heating surface*	975
Equivalent heating surface* ÷ grate area	59
Weight on drivers ÷ equivalent heating surface*	77
CYLINDERS.	
Diameter and stroke, H. P.	23¼ x 26 in.
Diameter and stroke, L. P.	34 x 26 in.
VALVES.	
Diameter and kind, H. P.	11 in. Piston
Diameter and kind, L. P.	12 in. Piston
WHEELS.	
Driving, diameter	58 in.
Driving axles, size,	Main 9½ x 12 in; others 9 x 12 in.
BOILER.	
Style	Radial stayed, wagon top
Working pressure	200 lbs.
Firebox, length and width	120 x 69⅞ in.
Firebox, water spaces	Sides 4½, Throat 5, Back 3½ in.
Firebox, thickness of sheets	5/16, ⅜, ½ and 7/16 in.
Tubes, Number and diameter in front section	281—2 in. O. D., 12—2¼ in. O. D.
Tubes, length in front section	96 in.
Tubes, number and diameter in rear section	289—2 in. O. D.
Tubes, length in rear section	109 in.
Heating surface, tubes	2605 sq. ft.
Heating surface, firebox	180 sq. ft.
Heating surface, total	2785 sq. ft.
Superheating surface	420 sq. ft.
Equivalent heating surface*	3415 sq. ft.
Grate area	58 sq. ft.
TANK.	
Tank, kind	Semi-Water Bottom
Frame, sills	Centre 13 in., Sides 10 in.
Trucks, kind	Equalizer
Wheels, diameter	34 in.
Axles	5½ x 10 in.
Water capacity	5,000 Imp. Gallons
Coal capacity	12 tons

*Equals total heating surface + superheating surface × 1.5.

On a ton mile basis, which is the fairest comparison for operating costs, it will be lower, due to the greater tonnage hauled, which, it is considered, together with the saving in fuel, will show considerable economy in favor of the Mallet locomotive.

WELFARE WORK.

In the year 1908 the International Harvester Company spent about $100,000 in its welfare work. This year it will probably spend a somewhat larger sum. This includes a system of profit sharing, insurance covering sickness, accident and death, also old-age pensions.

The company has been criticised by managers of other companies for making the plan too liberal and attractive. There is no doubt of the truth of this criticism in so far as the cost goes. No concern has ever put out plans that involved the application of so large a percentage of its profits to such plans. But the Harvester Company did not do this out of pure philanthropy. It had no intention of passing around a hat full of money, that employees might help themselves. It went into these enterprises in a purely business spirit, believing that the plans would so knit its vast organization together, would so stimulate individual initiative, would so strengthen and develop the *esprit de corps* of the organization as to make it possible for the company to increase its business and its earnings.

So far the company has every reason to congratulate itself on the result. In all parts of the company's business, at home and abroad, in the office force, in the factories, in the sales department, everywhere, the average interest of the individual in the business is greater than formerly. The saving of the waste here, there and everywhere is noticeable. The employees throughout the organization are vying with one another more and more to improve their respective branches of the business. This means profits for the stockholders, means extra compensation in various ways for the employees; in short, means co-operation that is real, that is beneficial to one and all.—*George W. Perkins before the annual meeting of the National Civic Federation.*

FACTORS OF SAFETY FOR LOCOMOTIVE BOILERS.

In the third annual report of the New York Public Service Commission, Second District, the inspector of locomotive boilers, Garland P. Robinson, proposes the following permissible factors of safety for boilers of different ages:

		Factor.
1.	Boilers with butt seams, under 30 years	4
2.	Boilers with lap and cover seams, under 20 years	4
3.	Boilers with lap and cover seams, 20 to 30 years	4¼
4.	Boilers under 20 years old with plain lap seams	4¼
5.	Boilers with plain lap seams, 20 to 30 years	4½
6.	Boilers 30 to 40 years old	5
7.	Boilers over 40 years old	to be condemned

The data for 7,724 boilers have been tabulated on the basis of these factors of safety with the following results:

NUMBER OF BOILERS WHICH DO NOT MEET THE PROPOSED STANDARD.	
Number of boilers, butt seams under 30 years, factor less than 4	60
Number of boilers, lap and cover seams under 20 years, factor less than 4	54
Number of boilers, lap and cover seams 20 to 30 years, factor less than 4¼	47
Number of boilers, lap seams under 20 years, factor less than 4¼	175
Number of boilers, lap seams 20 to 30 years, factor less than 4½	108
Number of boilers, any seams 30 to 40 years, factor less than 5	13
Number of boilers over 40 years	2
Number of boilers of unknown age	6
Total	465

In order to comply with the proposed standards the following reductions would have to be made in pressure:

Number of boilers to have pressure reduced 5 pounds	39
Number of boilers to have pressure reduced 10 pounds	95
Number of boilers to have pressure reduced 15 pounds	140
Number of boilers to have pressure reduced 20 pounds	71
Number of boilers to have pressure reduced 25 pounds	32
Number of boilers to have pressure reduced over 25 pounds	80
Total	457

In commenting on this the report states:

"The proposed standards above given have been submitted to all companies and their full criticism requested. Replies from all have been received. The suggestions meet with the approval of the majority of the roads, and while they are criticised by others, it appears probable that no standards could be fixed which would not meet with fully as much opposition. In the matter of lap seam boilers, for instance, one large road states that no additional factor of safety is required beyond that necessary for boilers with modern seams; and another equally prominent road states that lap seams should be prohibited by law.

"Most of the companies have agreed to comply with the suggestions of the Commission, and to condemn or strengthen doubtful boilers or to reduce pressures. The company which happens to have the largest proportion of locomotives which will be affected by the proposed standards, and which will therefore be subjected to the greatest expense for any changes which may be decided upon, writes:

"'The minimum factors of safety as indicated by you seem to be reasonable, and there is no engineering data or authority that will justify any recommendation for a lower factor than that suggested by the Commission.'"

GAS ENGINE DEVELOPMENT.—The development of the large gas engine within the last few years has been exceedingly rapid. It was only nine years ago that a 600 horse-power engine exhibited at the Paris Exposition was regarded as a wonder, but to-day four-cycle, twin-tandem, double-acting engines of 2,000 to 3,500 horse-power can be found in nearly all up-to-date steel plants, and there are installations in this country containing several units rated at 5,400 horse-power each.—*From Bulletin 416, United States Geological Survey.*

LOCOMOTIVE TERMINALS

A DISCUSSION OF THE ARRANGEMENT, DESIGN, CONSTRUCTION AND OPERATION OF LOCOMOTIVE TERMINAL FACILITIES TO OBTAIN THE GREATEST EFFICIENCY.

PART III.

Reporting Work.

Ordinary running repairs at practically all terminals are made on the basis of the written reports of the engineer who has brought the locomotive in, and of the inspectors who have inspected it. These reports, for obvious reasons, should be written, and the proper form of blank be filled out, to accomplish the best results.

When locomotives were smaller and less complicated the reports for repairs were usually made on what practically amounted to a blank pad on which was written a memorandum of what needed attention. Under modern conditions, however, it often happens that a report of this form would be of considerable length, covering several sheets, which would be difficult to record and file, to say nothing of the difficulty of deciphering some of the handwriting. It is the custom on some roads to have a printed sheet where practically all of the items that might possibly need reporting are given and it is necessary for the engineer or inspector to simply make an X after the item that requires attention.

One of the illustrations shows the front and back of a sheet of this kind, in use on the New York Central & Hudson River Railroad, which answers the purpose very well. The instructions printed on the back of this sheet show how it is used.

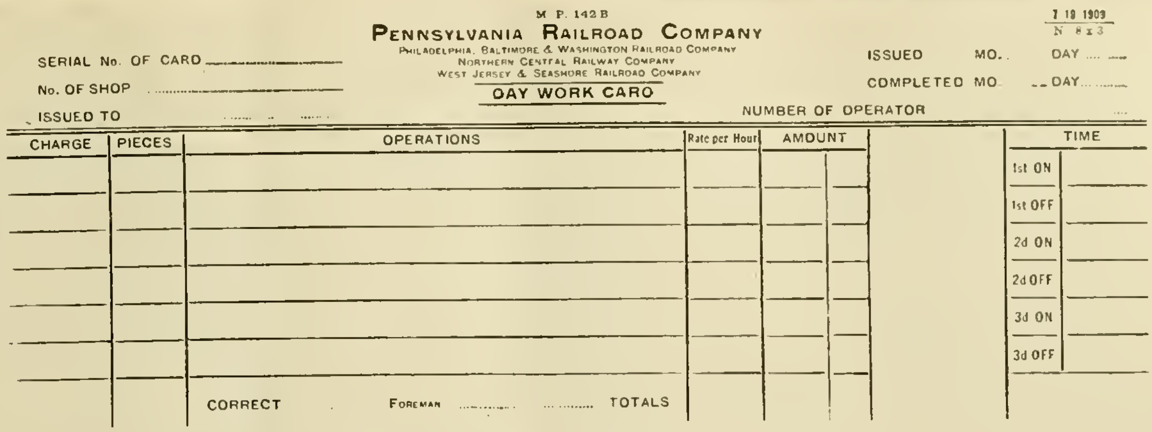
In connection with the description of the inspection pit and instructions to inspectors on the Pennsylvania Railroad given in the previous issue, the form MP-62 used by both the inspectors and engineers was illustrated. This blank answers the purpose under the conditions described very well, since each report covers only a very small part of the locomotive and there are five or six separate reports sent in at once, none of which could be very extensive. At points, however, where but one inspector is used and the engineer is required to very carefully go over the whole locomotive himself such a form would not be large enough.

In the Pennsylvania scheme the MP-62 reports, on arrival at the engine house, are removed from their carriers by the work clerk, who in all cases is a thoroughly practical mechanic, and the items thereon are transferred to other blanks, each separate job, or a number of minor jobs, being put on a single card. These cards are given to the work distributor, who in turn delivers them to the foreman in charge of each class of work. One of the forms used for this purpose in the engine house is illustrated. The piece work card differs from this very slightly. The column on the extreme right is for use in case a man is temporarily taken off from a piece of work on which he is engaged. Under such conditions the time is noted when he was taken off the job and he surrenders his card to his foreman, receiving in return another card. At no time may a workman have more than one card and that referring only to the work upon which he is engaged. On the other hand, the cards retained by the foreman always show the work that is not assigned and that which has been temporarily suspended. When the job is completed and has been inspected, the card is returned to the work clerk in the office, who checks it and fills in the total amount and files it in a case kept for that purpose.

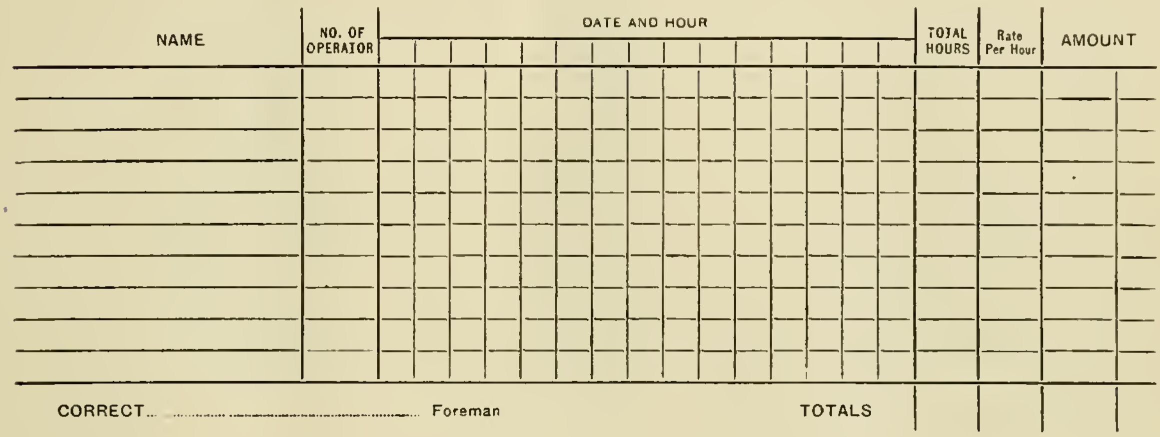
In order to prevent the necessity of writing out each item by the work clerk, an experimental card is being tried at some of the engine houses on the Pennsylvania, where piece work is in force, on which the separate items are printed in a column so arranged that a punch mark can be made opposite each. In using the card the work clerk simply punches the items requiring attention, as given by the MP-62 report, instead of writing them out. The sub-foremen also possess punches for indicating the jobs that develop while the work is being done. The piece work prices are printed on this card, and when it is returned, the record is complete and requires very little labor for recording. The illustration shows the face of one of these cards as a sample of the method. The back of the card has a double column of items similar to the single column on the face. There is a different card for each different class of work.

It will be noticed that in all of these cases the foreman is required to sign his name to the card and a record is kept of the

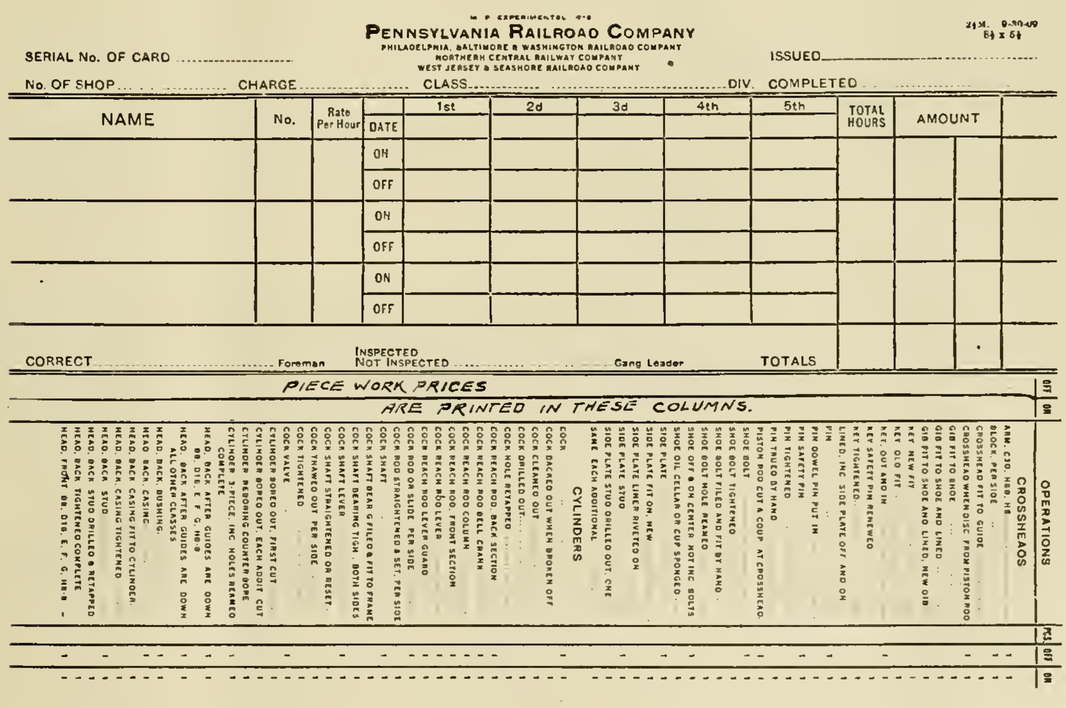
SYNOPSIS.



WORK DISTRIBUTION CARD—PENNSYLVANIA RAILROAD.



BACK OF WORK DISTRIBUTION CARD—PENNSYLVANIA RAILROAD.



EXPERIMENTAL WORK DISTRIBUTION CARD—PENNSYLVANIA RAILROAD

workman who performs the work. The files are usually made under engine number heads, so that it is a very simple matter to trace the workmanship to the workman.

The scheme for reporting, recording, distributing, and filing the work reports on the Lake Shore & Michigan Southern Railway was very fully described in the article on "Organization," which appeared in the December, 1908, issue of this journal and the following description is reprinted from that article:

When an engineer comes in off his run he verbally reports the work which is necessary on the engine to a clerk at the work report office. The clerk writes the report in a work report book and the engineer reads it, and if correct, signs it. In this way the reports are always kept clean and legible. The clerk makes out the work slips from the report book on a form about 3 x 5 in., similar to the one shown in the illustration; a separate slip is made out for each job. When the work cards have been made out, the clerk marks the work report in the book O. K., with the figure 1 or 2 underneath, showing that the items have been copied on work slips; 1 indicates that the cards have been made out by the day clerk and 2 by the night clerk.

The cards are placed on the engine foreman's desk along with all incomplete work reports (work reported but not done when engine was last in the house) for that particular engine; these latter cards are taken from the incomplete pigeon-hole, of the engine in question, in the file case.*

The passenger work cards are turned over to the passenger engine foreman and the freight and switch engine work cards are given to the freight engine foreman. These in turn distribute them to the various gang foremen or workmen, as the case may be, and when the work is completed, or at the close of the work period, receive them back. The engine foremen distribute and receive the cards so that they may have an exact knowledge of all of the work reported and in order that they may promptly report the engines for service when the work is completed.

If any of the inspectors or foremen discover unreported work, a report is made out and handed to the clerk, who copies it in the work report book, and the card is handled the same as engineers' cards.

As soon as the work has been completed the workman signs and dates the cards on the face, in a place provided for that purpose, and returns them to the gang foreman. If, for any reason such as lack of material, too short time, or the engine not dumped, the work reported cannot be attended to before the engine goes out, the foreman having the work card will make a note on the back of it to that effect, signing his name and date. This incomplete work card is then filed in the incomplete pigeon-hole, under the number of the engine. When the engine returns to the engine house the incomplete cards are taken from the pigeon-hole and handled as new cards. If the work has been done at the other end of the run the card is signed and handled in the usual manner.

A distinction should be made between cards for work, which upon inspection by the gang foreman is found to be in good condition, and cards for work, which, although necessary to be done, was not finished before the engine was allowed to leave this point. Cards of the first class refer to work which in the judgment of the engine foreman is in good condition and need not be done. Such cards should be signed on the face by the engine foreman, giving the date and stating that the work reported is not necessary. These cards are then ready to be filed as "finished" work.

Cards of the second class are for work to be attended to on the return of the engine; such cards should be signed and dated on the back along with a brief explanation why the work could not be done before the engine left the house. These cards are "unfinished" work reports and should be so filed. The gang foreman returns all completed cards to the office as soon as the work is finished and the incomplete cards at the close of the work periods, or when the engine leaves the house. If the engine is still in the house at the close of the work period, all incomplete cards for work which may not be done are turned over to the incoming gang foreman. The report clerk should file all finished cards as soon as possible and hold over the unfinished ones.

At the close of each month all finished cards are taken from file all finished and hold-over or unfinished cards as soon as possible.

FORM M. P. 200A

New York Central & Hudson River Railroad Co. CHS) 10-2-08-70M

MOTIVE POWER DEPARTMENT.

REPORT OF CONDITION OF ENGINE AT END OF TRIP.

Report of condition of engine No. ____ *after careful inspection on arrival at* ____ *M.* ____ *190*

Engine is in good condition, with the exception of the items marked X in column headed "Eng'r" and items reported under heading "other defects."

No.	Name of Part	Location	Eng'r	Insp.	Repairs made by	No.	Name of Part	Location	Eng'r	Insp.	Repairs made by
	HOT BEARINGS.						MACHINERY—CON.				
1	Journals					53	Knuckle Joint Pins				
2	Pins					54	Lost Motion in Link Motion				
	AIR BRAKE EQUIPMENT.					55	Main Rods				
3	Air Brake Equipment					56	Pack Journals				
4	" Pump					57	Piston Head Loose				
5	" Signal Equipment					58	" Rod "				
6	Brake Beams & Shoes					59	" " Broken				
7	Driver Brakes					80	" " Packing				
	BOILER					61	Pounds in Boxes				
8	Blow off Cocks					62	" in Wedges				
9	Brick Arch					63	Relief Valves				
10	" " Tubes Leaking					64	Reverse Lever				
11	Check					65	Rocker Boxes				
12	Chain Cab Defective or Leak'g					66	Rod Bushings				
13	Crown Sheet Leaking					67	Steam Chest				
14	Exhaust Pipes "					68	" Gage				
15	Firebox "					69	Strap Bolts				
16	" Doors "					70	Transmission Bar & Pin				
17	Flues "					71	Valves Blowing,				
18	" Stopped					72	" out of Square				
19	Foaming					73	Valve Rod Packing				
20	Front End Arrangement					74	Wedges Set up				
21	Gage Cocks						MISCELLANEOUS				
22	Grates					75	Ash Pan				
23	Grate Shaker Rigging					76	Bell Ringer				
24	Injectors and Pipes					77	Blower Pipe & Valves				
25	Mud Ring Leaking					78	Cab Repairs				
26	Safety Valve					79	Cellar Bolts				
27	Side Sheets Leaking					80	Coupler Defective				
28	Stay Bolts "					81	Headlight				
29	Steam Pipes "					82	Lost Motion—Engine & Tender				
30	Throat Sheet "					83	Lubricator				
31	Throttle "					84	Marker Lamps				
32	" Packing "					85	Oil & Grease Cups Fill or Apply				
33	" Lever					86	" " " Plugs				
34	Water Glass & Cocks					87	" Pipes				
35	Whistle & Rigging					88	Pedestal Bolts				
	MACHINERY.					89	Pilot				
36	Bolts Loose in Crosshead					90	Sander & Sand Pipes				
37	" " " R'k'r boxes					91	Sharp Flanges on Tires				
38	Crank Pin Loose					92	Springs—Buffer				
39	" " Collars					93	" Driver				
40	Crosshead Key & Pin					94	" Engine Truck				
41	Cylinder Leaking					95	" Tender & Trailer				
42	" Cocks & Rigging					96	" Eq'liz'rs & Hangers				
43	" Head Leaking					97	Steam Heat Gage				
44	" Packing Blowing					98	" " Hose & Pipes				
45	Driving Boxes					99	" " Regulators				
46	Eccentrics					100	" " Valves				
47	" Straps & Bolts					101	Tank Hose				
48	Frame Broken					102	" Leaks				
49	" Bolts " or Loose					103	" Valves				
50	" Splices Working					104	Tender Truck Brasses				
51	Guides Loose					105	Tires Loose				
52	" Lost Motion					106	Water Scoop				

Safety valve lifts at ____ *lbs. Safety valve sets at* ____ *lbs. Reservoir pressure* ____ *lbs. Train line pressure* ____ *lbs.*

OTHER DEFECTS

Engineman.

FACE OF ENGINEER'S AND INSPECTOR'S REPORT CARD—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

Supervision.

In practically all of the systems for assigning work by means of cards it is required that the foreman of the gang doing the work shall sign the card, before it is turned in, as a record that he has inspected the finished work and found it satisfactory. Of course, there is much work done around a roundhouse that it would be impossible to inspect, but inasmuch as the workman's name is also on the card it is easy to soon discover an unreliable man.

NEW YORK CENTRAL LINES

FORM 2668. S. 9657. 200m. 8-08. (GES 85112)

LOCOMOTIVE WORK CARD. No. ....

Eng. No.	Eng'r........or Insp........	Place and Date

Work Performed by	Date

ENGINE HOUSE WORK REPORT CARD—L. S. & M. S. RY.

* These file cases consist of pigeon holes $3\frac{1}{4}$ in. wide and 3 in. high, one for each engine, sub-divided by tin slides so that the upper section, $\frac{3}{4}$ in. high, may be used for incomplete work cards, while the lower part, $2\frac{1}{4}$ in. high, is used for finished work reports. These files are in the office of the clerk, in which no one is allowed to enter but the clerk and the engine-house foreman. The engineers' reports are dictated through a window. The hostler reports the engine numbers as soon as the engines are placed in the house or on storage track, so that the clerk can immediately place the incomplete work reports, if there are any, on the foreman's table.

Enginemen must carefully inspect their locomotives before turned over to engine house force, or at the end of each day's work. Engioemen will be held responsible for reporting on this form all defects which can be seen by them from the outside, or observed on the road. Enginemen must make report on one of these forms whether the engine requires repairs or not, and most always fill in items "Safety Valve lifts at .....," "Safety Valve sets at......," "Reservoir Pressure ....." and "Train Line Pressure . " No attention will be paid to verbal reports or reports not signed by enginemen.

Items numbers 6, 13, 24, 34, 35, 40, 42, 47, 70, 77, 90, 95, 96 and 98 contain two or three items each; when reporting aoy of the items for any of these numbers for repairs, draw a line through the item which is in good condition and which is NOT io need of repairs.

The Engineman, to report an item in need of repairs, should place an x after the item in column headed "Eng'r," and the Inspector, to report an item in need of repairs, should place an x after the item in column headed "Iosp.," thus:

No.	Name of Part	Location	Eng'r	Insp.	Repairs made by
1	Hot journal	R. M. D.	x		
93	Springs—Driving	L. F.		x	

would indicate that the Engineman had reported the right main driving journal as running hot and that the Inspector had reported the left forward driving spring in need of repairs.

When repairs have been made the Foreman or the man in charge of the work must draw a circle around the x which indicates that the repairs have been made, thus:

No.	Name of Part	Location	Eng'r	Insp.	Repairs made by
1	Hot journal	R. M. D.	⊗		John Smith
93	Springs—Driviog	L. F.		⊗	W. Jones

would indicate that the hot driving journal reported by the Engineman had been repaired by John Smith, and the left forward driving sprіog reported by the Inspector had been repaired by W. Jones

The following items reported onder the headiog "Other Defects" have been repaired:

Item Reported	Repairs Made By

When items are reported as in need of repairs and the repairs are not made, the Foreman or the the man in charge of the work must give the reasons for not makiog the repairs in columo headed "Repairs Made By."

Rrservoir Pressure____lbs.} as found. Reservoir Pressnre____lbs.} as corrected.
Train Line Pressure____lbs.} Train Lioe Pressnre____lbs.}

Repaired at ____________________

Repairs completed____________190___at________M

Repairs made by____________________
Name of workman in charge of work

Iospected by____________________
Engine Inspector.

Air Brakes Inspected by____________________
Air Brake Inspector

Approved by____________________
Engine House Foreman.

Note:—The workman in charge of the work, Engine Inspector and Air Brake Inspector will sign this report and hand it to the Engine House Foreman, who will approve same and forward to the Master Mechanic, or the Division Superintendent of Motive Power.

BACK OF ENGINEER'S AND INSPECTOR'S REPORT CARD—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

It is the custom in some engine houses where piece work is in force to have a certain number of day workers and to use them for all work which cannot be thoroughly inspected, the piece work jobs being only those that are not concealed.

Ample supervision of engine house forces is of an importance equal to that of ample facilities. The work at this point does not generally attract the highest class of workmen, and it is often necessary to use men that are not thoroughly trained and who need considerable instruction. Unexpected difficulties and annoyances are very numerous, in all of which cases, if there is some one available who has authority and time, the work will proceed with much greater smoothness and rapidity. It is a great mistake to have too few foremen in an engine house. While they appear on the payrolls as non-productive labor, they are really the most productive class of men employed and even in indirect ways are often enabled to save the company the amount of their monthly salaries in a day or even in a few hours. In selecting engine house subforemen it is very advisable that men who have been trained in engine house work be selected. It is, of course, well that they should have had other experience, but the peculiar conditions of the handling of running repairs need special training in that line.

Work to Be Done.

It is impossible to formulate a rigid rule for what work shall be done in engine houses and what shall not. It is profitable at some points to make fairly heavy repairs in an engine house, work which will sometimes occupy as much as a week or ten days. Again, some engine houses are not permitted to do any heavy repairing and are not equipped for doing much machine work. Where the house is a long way from a repair shop and is handling a large amount of power it must be to a considerable extent self-supporting. Again, where it is located adjacent to a heavy repair shop it is usually considered that it should depend upon the shop for all the heavy work. The advisability of the latter arrangement is open to question.

Under average conditions it may be said in general that facilities should be provided for taking care of all work that does not require the actual renewal of some major part which would require machining and fitting. It probably is not advisable, as a general thing, to arrange for the renewing of tubes in an engine house, although this is sometimes done. All boiler repairs which require the renewal of any large part will under ordinary conditions keep the locomotive out of service a sufficient length of time to make it advisable to send it to the shop where other repairs that may not be immediately necessary can be made while it is laid up. Engine houses should be provided with facilities for removing the wheels, for turning the tires—unless standard wheel centers are in use when they can be changed instead of turned—for facing shoes and wedges, refitting driving boxes, renewing rod brasses, renewing cross head gibs, patching or welding frames as a temporary repair, doing all required repairs to the brake rigging, renewing bushings on the valve gear, renewing eccentric straps, facing off valve seats and all work of this character.

Where the locomotives are thoroughly standardized it is possible to supply the engine houses with parts which are already finished to standard dimensions and in such cases much more extensive repairs can be made in the engine house than would be otherwise advisable.

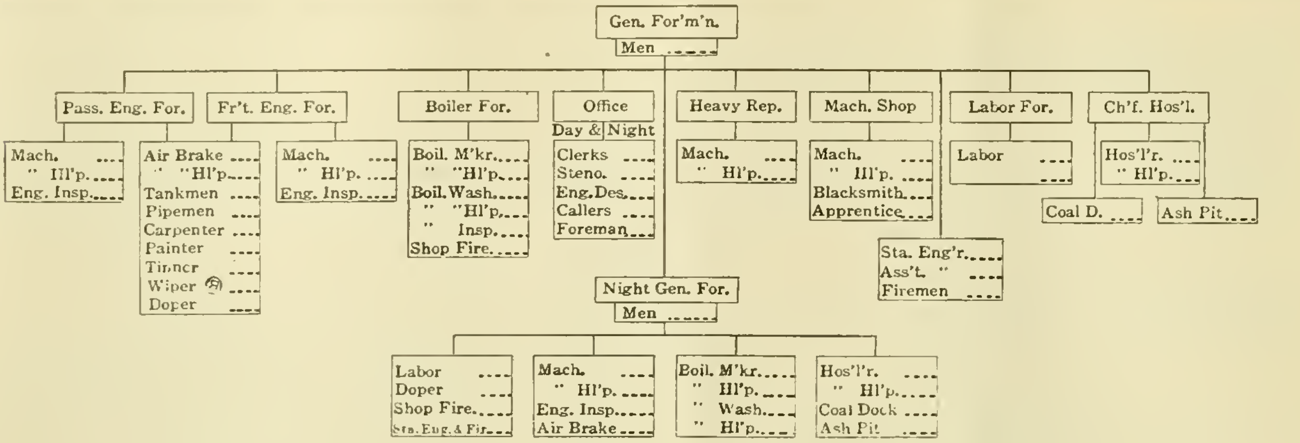
All the engine houses built in the last 8 or 10 years are provided with drop pits or drop tables for removing wheels and in the case of the Ashtabula engine house of the Lake Shore Railway, at least, an overhead crane of a capacity sufficient to lift a locomotive is provided. At this place all of the wheels can be removed and the locomotive be placed on blocks in a convenient position for making other repairs in about five minutes after the rods and pedestal binders have been removed.

Machine Shop.

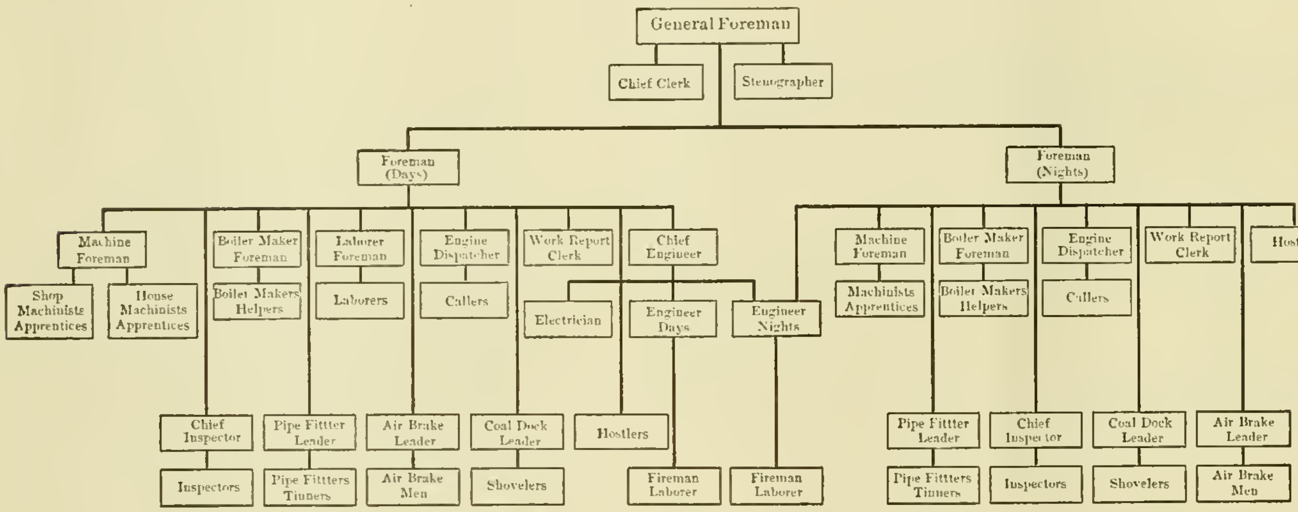
At all terminals turning more than 100 locomotives per day and in some cases at those turning less than this, a complete machine shop should be provided. This does not mean that it necessarily should be extensive or that all of the tools that are found in a repair shop should be included, but means that there should be at least one of each class of machine that work of this character might require. A driving wheel lathe of a capacity to take the largest wheels is very essential if standard centers are not in use, when it will probably be advisable to turn all tires at the

REMARKS—Wby Not Dooe	Foremao	Date

BACK OF ENGINE HOUSE WORK REPORT CARD—L. S. & M. S. RY.



ORGANIZATION CHART FOR A LARGE LOCOMOTIVE TERMINAL—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



ORGANIZATION OF FORCES IN A LARGE ENGINE HOUSE.

main repair shop. A planer of a size sufficient to take in a large frame brace and also suitable for shoes and wedges will be required; a lathe large enough to swing a rocker arm and probably two other sizes of lathes, one being intended for bolt work and the other of possibly 18-in. swing for general work will answer the requirements for that equipment; a medium size shaper and one radial drill; a vertical drill, a bolt cutter, pipe threading machine and cut-off saw will complete the usual tool equipment with the exception of a boring mill, which is probably one of the most important tools to place in an engine house. An hydraulic press of a size suitable for driving box brasses and a portable crank pin press should also be provided.

Jib cranes, air hoist trolleys, etc., for convenient handling of parts that require machining, will, of course, prove as valuable here as in a larger shop. The tool room should have a very complete equipment so far as various sizes of tools are concerned. It is sometimes surprising to discover how much money is lost through the inability to use a locomotive on account of the absence of a certain size of drill or reamer that is required, or by an engine failure on the road due to makeshift methods that have been compulsory on the part of the roundhouse force for the same reason. A locomotive broken down on the road will very soon lose enough money to provide a complete outfit of drills and reamers for the engine house.

A forge shop equipped with at least one good-size power hammer and a number of open forges will, of course, be found necessary. Under normal conditions no regular carpenter shop would be provided or required.

In a number of the later engine houses a narrow gauge industrial track has been set into the concrete floor all around the outer circle beyond the engine stops. This track is provided with turntables and switches, so that it extends into the various shops, store house and the scrap bin, and in some cases alongside the drop pits. Small push cars are operated upon this track and all heavy transporting is done by means of it.

Organization.

In no single way, or in fact in no combination of ways, can the cost of maintaining the locomotives in service be reduced as much as by means of a sound and thoroughly efficient organization. This feature is really very little understood on some railroads and the wonderful results that will follow its introduction are realized only by those who have discovered it by experience.

Of course, organization is a very broad term and many of the features that have been mentioned throughout these articles are part of this subject, but one of the most important features is the classification of the forces and the distribution of responsibility for results, so that, first, there is no confusion in any man's mind as to what his duties are, and, second, that his duties are within his capability. The old method where a roundhouse foreman had 100 or more workmen under him, all on the same grade, he being the only man who could sign requisitions, assign work, or clear up difficulties, was an enormously expensive one.

The accompanying illustration shows the arrangement of the forces at a large engine house where this subject has been given the closest attention, and while this exact arrangement probably is not suitable for all points, it illustrates the basic idea of the

FORM M.P. 297-A. C.H.S. 11-12-09-10M.

New York Central & Hudson River Railroad Co.

EMPLOYMENT AND CONDITION OF ENGINES.

..................Engine House, 8 A.M. ....19....

		Total
Through Passenger		
Local Passenger		
Through Freight		
Local Freight		
Switching		
Grade or Pushing		
Work Train		
Reserve		
For Sale or to be Demolished		
Stored		
Loaned		

IN ENGINE HOUSE UNDER REPAIRS.

Eng. No.	Service	Hours Work Required	Eng. No.	Service	Hours Work Required	Eng. No.	Service	Hours Work Required	Eng. No.	Service	Hours Work Required

Ready for Service	
Total	

..................Engine House Foreman.

All engines giving out on the road or that have been in collision during the past 24 hours should be reported under

REMARKS:..................

(SEE INSTRUCTIONS ON BACK)

DAILY REPORT FORM, SHOWING CONDITION OF POWER—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

NOTICE ON BACK OF ABOVE FORM.

This form should be filled out and forwarded to the office of the Division Superintendent of Motive Power showing employment and condition of each engine assigned to the point reporting or coming under the engine house foreman. Report to be taken at 8 A. M., and to give individual engine numbers.

All engines that are assigned to regular runs, or that are in daily service, should be reported under the respective headings according to the service or class of work they are performing.

Engines to be reported as "RESERVE" are such engines as are not regularly assigned to runs or other daily service, but are being held at the engine house to be used in case of an extra, or to take the place of an engine that is disabled, or is out of service for boiler washing or inspection.

Engines to be reported as "READY FOR SERVICE" are such engines as are in regular freight or switching service, and have had the fire cleaned, have been loaded with coal and water, inspected, and have had all necessary repairs made, and are waiting call for train, or other service.

distribution of responsibility through many channels which are all combined under one supreme head. This is a straight "line" organization of the simplest kind and if properly subdivided will probably prove to be the most efficient.

Another illustration is given of the organization of a larger terminal. This is taken from the article on the "Organization of the Lake Shore & Michigan Southern Railway" which is mentioned above. It shows an almost ideal arrangement which has proven to be thoroughly practical in every way.

Miscellaneous.

In the West Springfield engine house of the Boston & Albany Railroad has been instituted what amounts to a running log. This is maintained by the day and night foremen simply for their own information and record, and while it is filed for reference it is not in any manner official. In this log are jotted down such items as one foreman thinks the other may wish to have information upon. Much of this information is, of course, recorded in the dispatcher's book. No attempt is made to make this record complete in the matter of everything that happens; only such things as may come up later are noted. The log is kept in two parts, one being the engine situation, showing what engines are ready for service, what ones are held for repairs and what engines have been put into service, where they went and with what crew. The other is items of general information. Extracts from this part of the log, kept by the night foreman, are given below.

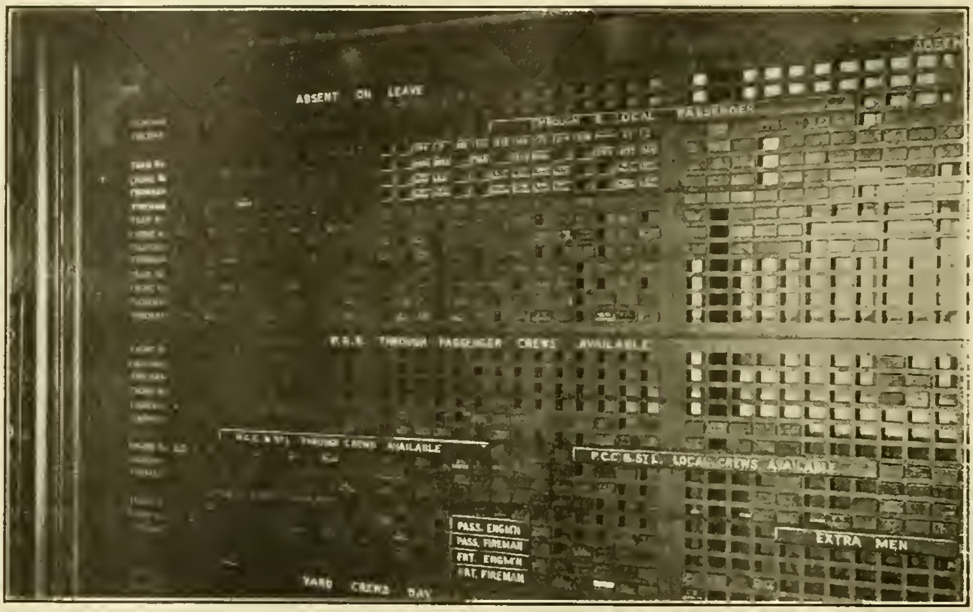
FRIDAY, JANUARY 7, 1910.

1910—Gone on No. 37—3523 off acc't flues leaking.
1151—Helping 37 with Burns and Davis.
2031—Gone on helper 43 with Makey and Devine.
3518—In on 49 returned on No. 28.
3520—In on 34—3501 returned on 70—3520 dumped, flues leaking.
3525—In on 35—3520 returned in place on No. 32.
3535—Gone to Albany light with Fox and Jones.
3506—Came up on 69—3539 in place on No. 36.
3535—Came down on Sec. 18 with Smith and Johnson.
1151—Thomas and Tobin came in on help 32.
3514—3552—Dumped acc't flues leaking.
1152—1909—3522—Coming on Pullman trains. Sec's of No. 3 can get no definite information.
2515—Gone on 1 A. M. switcher with Ripley.
2507—Gone on ice train place of 2542 that is out of service.
2524—Gone on Westfield Sus. with Kenyon.
3641—Gone on local east place of 3625 that is being held here acc't flat tender wheels.
2504—Still at Palmer. Dispt. will have eng. towed in by some helper; none out during night.
1914 Came up with Eng'r Parsons. Suppose this eng. should be held for her regular crew as their clothes and tools are locked up on eng. All the regular fast freight crews went last night except Attridge and Ward.
1905—Came up with W. White and is here for NH2.
1908—Here for B. A. 2. 1906 has not arrived yet.
Potter and Lempke are here for spare time, commences 4:30 A. M.
3506—Here for No. 6—3525 for 26—3514 for 361—1917 O. K. 3532 for 15.
3527—O. K. except left check pipe burst. 3523—Ready for a fire.
Ren's wired office last night that 2624 has very bad tender wheels, flat and shelled.
You will have to notify James and Holden that Supt. wants them at 10 A. M. to-day at his office.
Clancy will call up in a few minutes and let you know about Pullman trains coming.
2602—Has steam heat working. They will want this engine for Pullman train I think.
New fireman that you left here is here yet. Still waiting; had no freight job for him during the night. He is now in rest room.

The form used on the New York Central Lines for reporting the condition of power to the division superintendent of motive power is shown in another of the illustrations. This form is official and is forwarded each morning from all engine houses.

Posting of Blue Prints.—It is the custom on some roads to post in the engineers' room at the engine house a blue print showing all the tracks, switches and signals at that terminal. This print includes the identification mark of each tower, signal post, etc., and is found to be very valuable, especially in connection with orders that may be issued by the superintendent for the guidance of engineers in the use of certain tracks.

Dispatching Board.—A very successful type of dispatching board, which is in use at the Pittsburgh engine house of the Pennsylvania Railroad, is shown in the accompanying illustrations. This is placed behind glass in the partition separating the engine dispatcher's office from the enginemen's room. It is made up of a number of units of convenient size put into one frame and is thus capable of ready expansion as required. Each



DISPATCHING BOARD, PENNSYLVANIA RAILROAD AT PITTSBURGH.

of the units is made up of 5 plies of ¼-in. oak glued together with grain crossed to prevent warping. Rectangular holes, 1¼ x¾ in., are cut through the board and plugs, having flanges at one end to prevent their being pushed through too far, are inserted in the holes. These plugs bear the engine number or engineer's name as needed. The names on the plugs are large enough to be read by the dispatcher without getting up from his desk and a 12-section board has been found of sufficient size to care for the dispatching of from 150 to 200 engines per day. The titles are made up on strips which have plugs on their back, so that changes can be made readily without the scraping off of old and painting on of new titles. The illustration shows the construction of the board and plugs.

Another type of board, that has been found very convenient, is arranged in a circular frame and set behind a window in the partition between the dispatcher's office and the enginemen's room. The drum is made of sheet iron, painted, and mounted

PLUGS USED IN DISPATCHING BOARD ON PENNSYLVANIA RAILROAD AT PITTSBURGH.

so as to be easily revolved and the engine numbers and names of the crew are on tags which are hung on hooks in the proper location under the different runs. The board is provided with a circular handle at the bottom which extends through an opening into the enginemen's room and thus can be revolved to bring in view any particular run that anyone wishes to see. It can in the same manner be revolved by the engine dispatcher who marks up crews without leaving his desk.

Cans for Waste.—In a number of the better maintained houses large galvanized iron cans, about 3 ft. in diameter and 4 ft. high, are set alongside the posts between every 5th and 6th pit for the receiving of pieces of waste, sweepings from the floor and other scrap of this nature. Nothing of any value is put in these cans, which are emptied periodically on to the scrap car. Their presence to a large extent prevents the collection of miscellaneous waste material in the bottom of the pits and exerts a decided influence in keeping the house in a cleanly condition.

Soda Ash Solution.—Where soda ash is used generally it has been found that the best method is to dissolve it in large tanks, having the solution of the proper density, which is put into the tenders by means of buckets. This insures the proper amount of soda being put into each tender and is much more satisfactory than to put in the soda as a powder.

Hydrostatic Tests.—The injector for making hydrostatic boiler tests can be easily mounted upon a cart and be connected to the steam and water line connection between the pits. The boilers can in this way be tested with very little difficulty or expense.

Cleaning Gang.—Three or four men, whose regular duty it is to go over the whole house the first thing every morning, picking up everything that is lying around the floors or in the pits, piling it upon a cart and afterwards salvaging the serviceable material and putting it into its proper place and dumping the refuse, will keep an engine house looking neat and clean at a slight expense. In fact, the good material which they are able to salvage, that would otherwise be lost, probably more than pays their wages.

Lamp Guards.—The guards for incandescent lamps, particularly the portables, should be very substantially made of heavy galvanized wire and provided with a strong hook by means of which they can be hung up on rods and other places around locomotives. The bottom of the guard should be flat and large enough so that the lamp can be set up on a flat surface without any danger of it being easily tipped over. Removable cross wires, forming a protection on the bottom, should be provided.

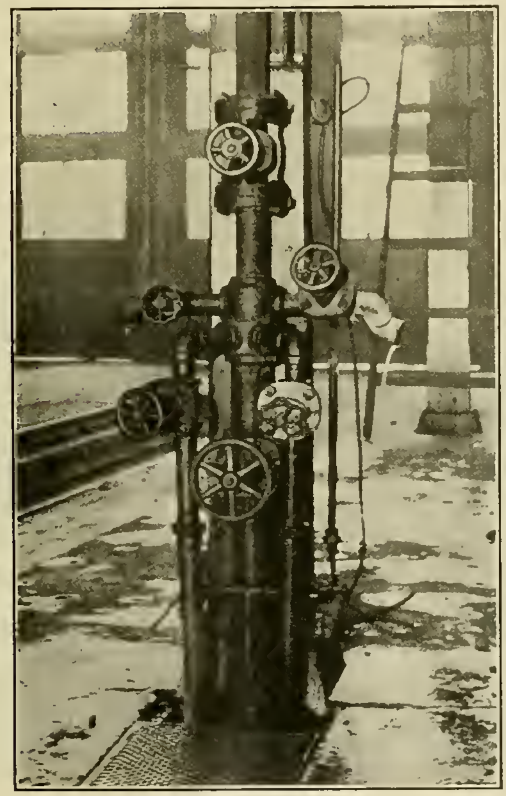
Clothes Lockers.—If the clothes lockers are in the main engine house instead of a separate building they should not be of the expanded metal type, as these permit the smoke, gases and soot to easily get inside the lockers, and soil everything therein. In such cases, of course, ventilation should be provided, but not openings large enough to allow the dirt to get inside. By far the better way is to use expanded metal lockers and have them in a separate building in connection with the toilet facilities, etc.

Crane on Incoming Track.—For the purpose of removing air pumps or other heavy parts, that may be shipped upon the tender of passenger locomotives, an air hoist on a jib crane extending over the incoming track leading to the turntable, or some other convenient location, has been found most convenient. The same crane, of course, can be used for loading the heavy parts that are to be shipped to the shop or other points.

Permanent Jib Crane.—No expense of time or money was spared in making the East Altoona engine house of the Pennsylvania Railroad as near perfect as possible and, among other ex-

PERMANENT JIB CRANE ON OUTER LINE OF POSTS. ONE OF THESE CRANES BETWEEN EACH TWO PITS AT EAST ALTOONA ENGINE HOUSE—PENNSYLVANIA RAILROAD.

cellent features, there are installed on each of the outer row of posts between the pits a swinging jib crane made up of I-beams and carrying a triplex chain hoist on the roller carriage supported by the flanges of the arm. These arms are long enough so that any of the heavy parts near the front end of the locomotive can be easily handled by properly locating the engine. They have been found to be one of the handiest things for an engine house. Front end rings, smokestacks, bells, steam chest



HOT WATER WASHOUT SYSTEM, MANIFOLD PIPE LINES IN CONDUIT.

covers, bumper beams, headlights, etc., are easily and quickly handled with it.

Washout System.

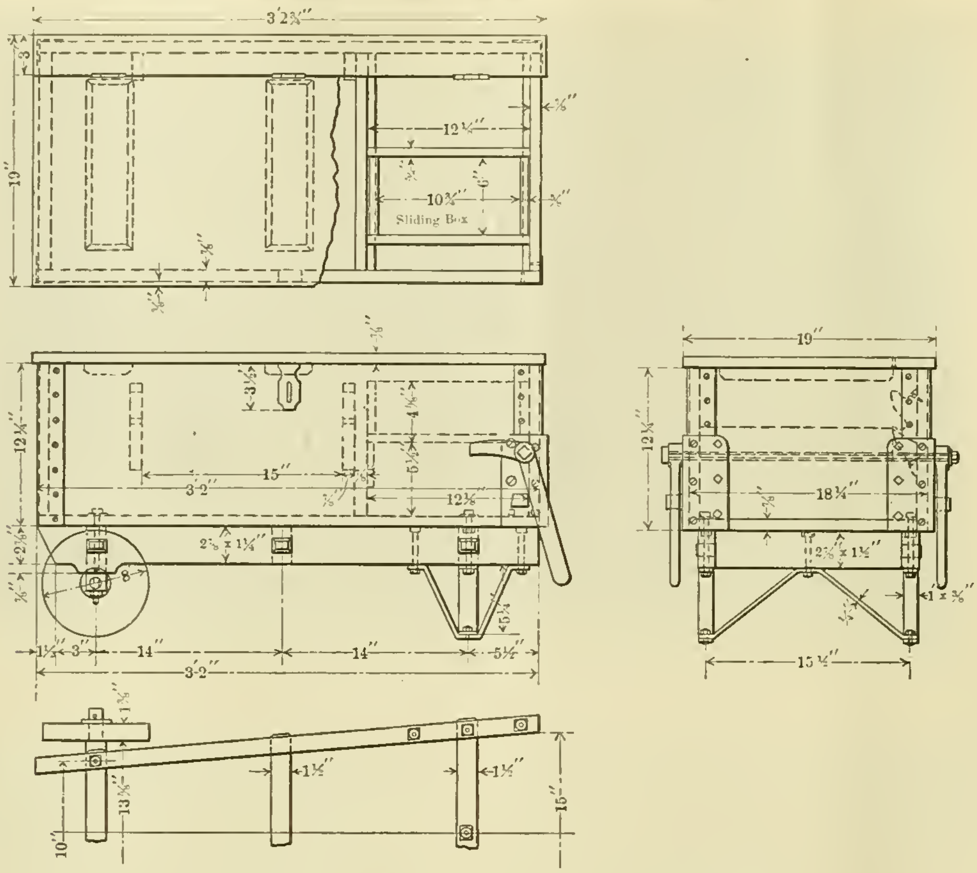
It can be said without fear of contradiction that every engine house in which large boilers are washed should be provided with a hot water wash out system. The saving in the time that a locomotive is kept out of service for boiler washing makes such a system very profitable to say nothing of the increase in the life and improvement in the condition of the boilers themselves.

The most successful systems provide a plant consisting of the necessary drums and pumps located in a separate section of the house from which are carried the various pipe lines terminating in connections between every second pit. In some cases these pipes are carried in conduits near the outer or inner circle and have connections extending beneath the floor, which are brought up to manifolds on the posts between the pits. The conduits are covered with iron gratings so that repairs can be easily made. In these cases there is also a line carried around the roof of the house for a connection to the blow-offs on the dome which

FRAME HOLDING CONNECTIONS TO PIPE LINES OF ALL KINDS—WEST SPRINGFIELD—BOSTON & ALBANY RAILROAD.

has a connection to the same manifold. One of the illustrations shows an arrangement of this kind, which includes a large blower pipe brought up from below, a hot and cold water line and a connection on either side for the attachment of the hose.

In some other cases the pipe lines are all carried from the roof timbers at the top of the house, connections being brought down at the posts in a similar manner. The advantage of the manifold in a case of this kind is that a mixture of hot and cold water, or of steam and water, can be made so that the proper temperature is easily obtained. The disadvantage lies in the



PORTABLE MACHINIST'S TOOL BOX FOR ENGINE HOUSES.

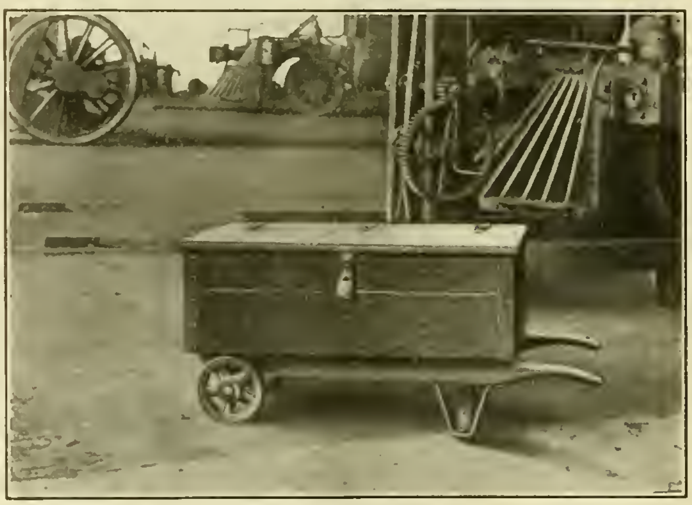
fact that the wash out water can be cooled down below the most satisfactory temperature by the man doing the washing, who finds it more convenient to handle the hose when it is not so hot. One of the illustrations shows a rack for holding the pipe terminals from the overhead line that is in use at the West Springfield engine house, where the location of the posts are inconvenient for this purpose. At the time the photograph was taken the overhead wash out system was not installed, but the places where the various pipes go on the rack are indicated. In this case no manifold is used, each pipe terminating in a Y, to which is connected two valves. The lines shown in the illustration are steam, water and air. In addition to these there has since been installed the blowing off line, the hot water wash out line and the hot water line for filling boilers. This makes a very neat and satisfactory arrangement of piping.

On account of the large amount of space required a description of several of the hot water washout systems will be delayed until a later number.

HANDY DEVICES.

Portable Machinist Tool Box.—A roundhouse machinist under modern conditions of piece work or bonus payment finds it necessary to have available a large supply of tools, more than it is possible for one man to carry in his hand from place to place. In fact, in houses where the highest efficiency is being maintained, it has been found to be good practice to equip each machinist with wrenches, jacks, etc., that in most houses are common property and stowed away in one place. In order to make it possible for a man always to have his supply of tools available and easily transportable, a tool box, which in effect is mounted on a two-wheel baggage truck, is used. This box is long enough and large enough to take in any tools that would be ordinarily required and is fitted with a substantial hasp and lock. The complete equipment of these tools is charged against each machinist, and he is held responsible for their safe keeping. Two designs of this type of tool box are shown in the illustrations, one having an ordinary wooden handle and the other fitted with iron handles, which drop down out of the way when not in use. These boxes are sometimes made of sheet metal instead of wood, although the latter is perfectly satisfactory. These boxes are also convenient for use as benches to stand upon.

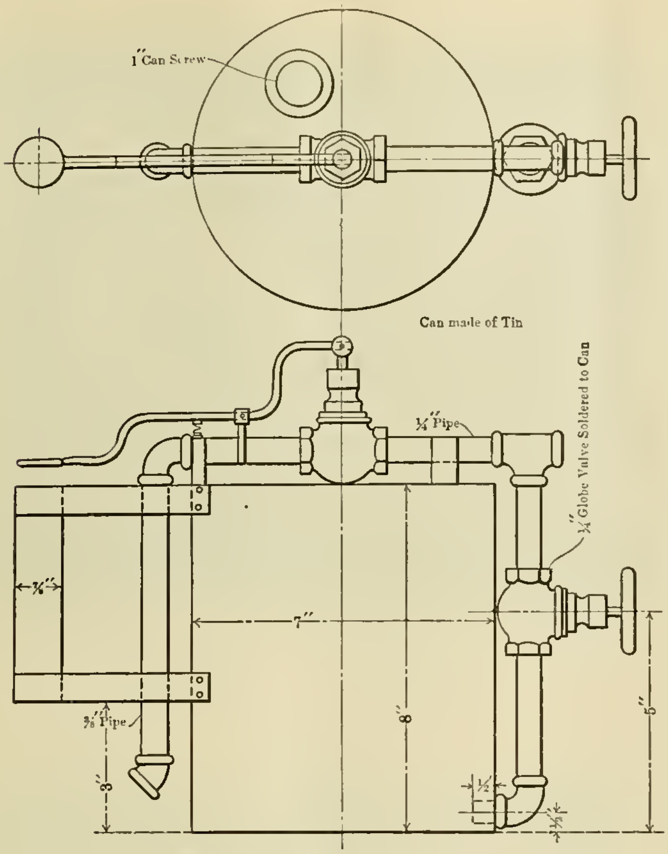
Cleaning Waste.—While waste that is used by wipers is usually considered a negligible expense, and after it has become too dirty for further wiping is used to kindle fires at most places, still at points where this subject has been carefully investigated it has been found that it is well worth while to collect the waste that is discarded by the wipers, thoroughly wash it, and put it



PORTABLE MACHINIST'S TOOL BOX—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

again into use. At such points fires are kindled with crude oil either poured directly on the fuel, or by means of a special firing-up machine.

The waste discarded by the wipers is put into special galvanized iron receptacles distributed throughout the house and is collected and thrown into a large vat of crude oil, where it is



SPRAYER FOR PAINTING FRONT ENDS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

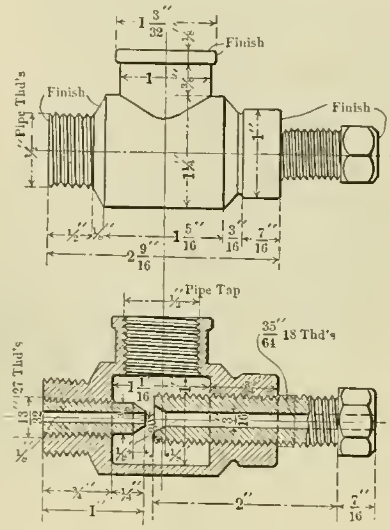
thoroughly churned up, loosened, and a large part of the dirt washed out. It is then put through an ordinary wringer and goes to another vat of oil, where it is again washed and put through a second wringer. At the second wringing it is not wrung dry, but is left in the proper condition for the wipers to use. It is then put into boxes from which the wipers draw their supply. The oil in the first vat, of course, soon becomes

PAINT SPRAYER FOR PAINTING FRONT ENDS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

dirty and is cleaned out periodically, usually being thrown away, although it can be filtered if desired. The oil from the second vat is then transferred to the first one and fresh oil is put in the second or rinsing vat. One man with an arrangement of this kind will take care of all of the waste used by the wipers in a large engine house.

Paint Sprayer for Front Ends.—The appearance of locomotive front ends is a matter of pride with most master mechanics and especially in the case of passenger power it is necessary to continually repaint them. On the Lake Shore & Michigan Southern Railway a spraying device has been designed for coating front ends that is most successful in every way. It is found that front ends painted with this sprayer do not blister as quickly and hold a good appearance a longer time, due to the fact that the paint is put on in a thinner and hence a more elastic coat. It is also found that it requires less paint. One man with a sprayer of this kind can paint a whole front end of a large locomotive, doing as good a job as it is possible to do, in less than five minutes.

The sprayer, which is shown in two of the illustrations, consists of a small tin can about 7 in. in diameter and 8 in. in height, provided with a nozzle and suitable pipe connections fitted with valves and connected as shown in the drawing. Connection is made to the air supply by a hose and the air valve is fitted with a spring handle operated by the thumb of the hand that is holding the sprayer. The nozzle is shown in detail; it is simply a



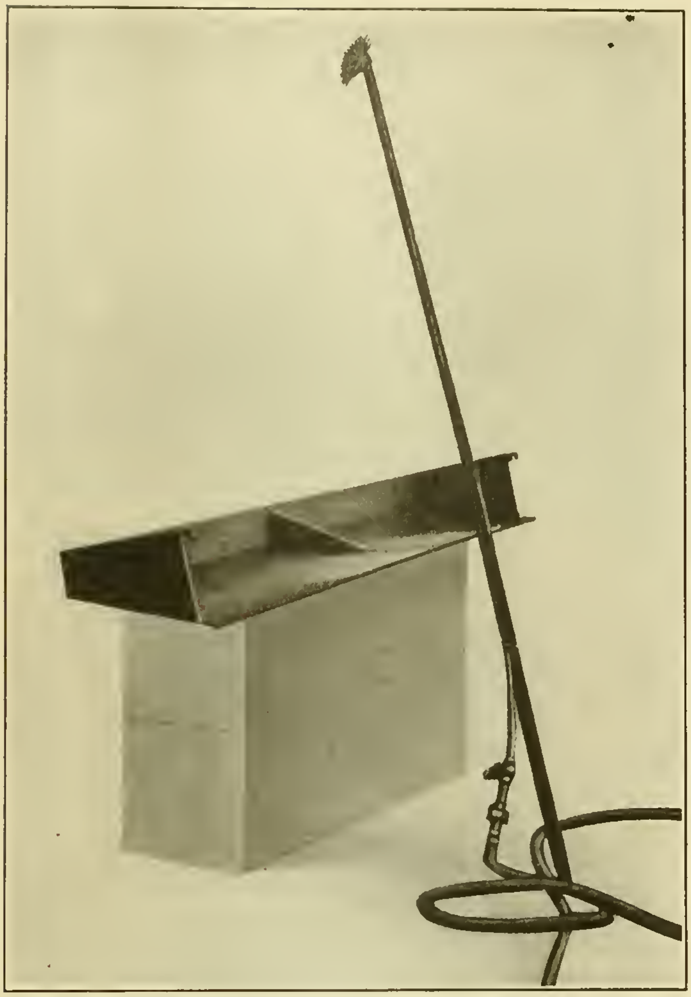
NOZZLE FOR FRONT END PAINT SPRAYER—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

brass fitting arranged on the ejector type. The whole apparatus filled with paint can easily be handled by one hand, and as the stream is not allowed to spread widely a very careful and satisfactory piece of work can be quickly accomplished with it.

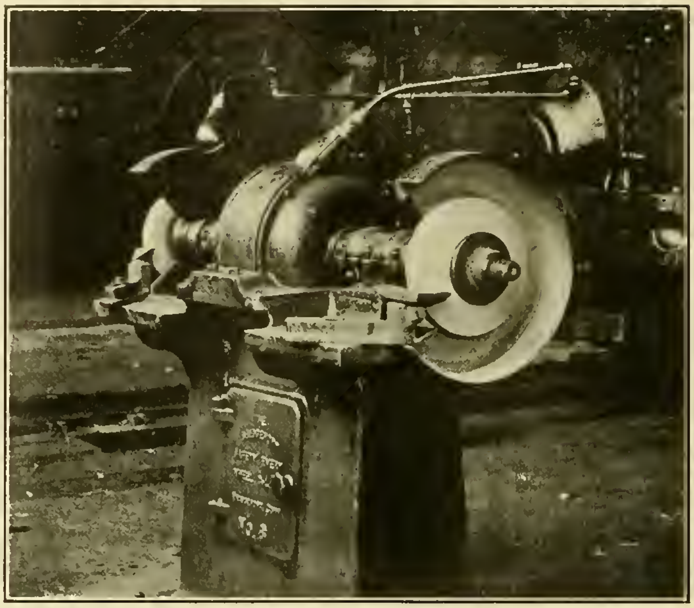
A similar sprayer is also used for tender and engine trucks, pilots, or other places where a paint sprayer can be used to advantage.

Bulletin for Boiler Washers.—In some roundhouses it is the practice to have a small blackboard properly ruled and located in a central location on which the numbers of the locomotives that are in the house and require boiler washing are noted by the work clerk. The number of the stall on which it is located is placed opposite the engine number and the boiler washing gang only have to keep track of this board for instructions. After the boiler is washed it is crossed off from the board, which acts as a notification to the foreman that the work is finished.

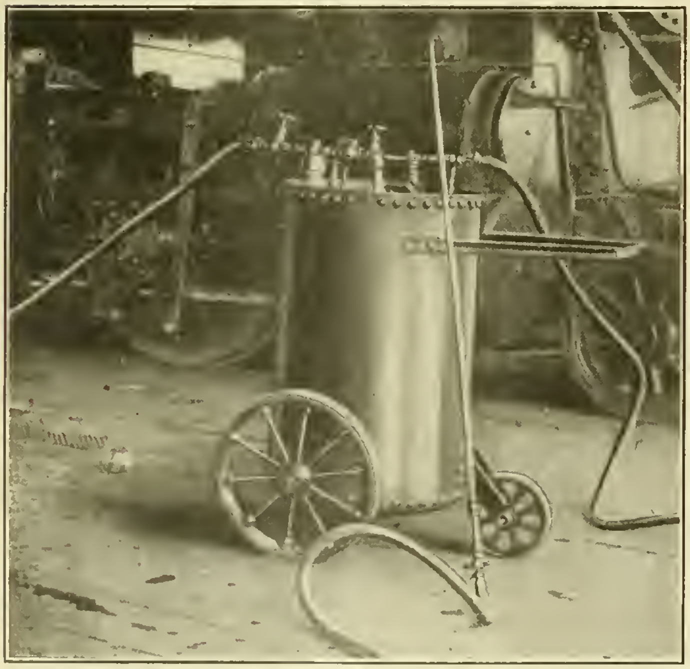
Throttle Gland Packing from Old Air Hose.—It is the practice in a number of shops and locomotive terminals to make packing for throttle stems from condemned air brake hose. For this purpose the hose is split lengthwise and the rubber washers of the proper size are made by a cutter, usually operated by air, the machine consisting simply of an eight inch brake cylinder, mounted vertically, with the cutter on the end of the piston rod and working against a wooden block. In applying packing of this kind the gland is filled up with alternate rings of washers from the hose and of one-sixteenth inch lead. It is found that this packing is cheap and answers the purpose admirably.



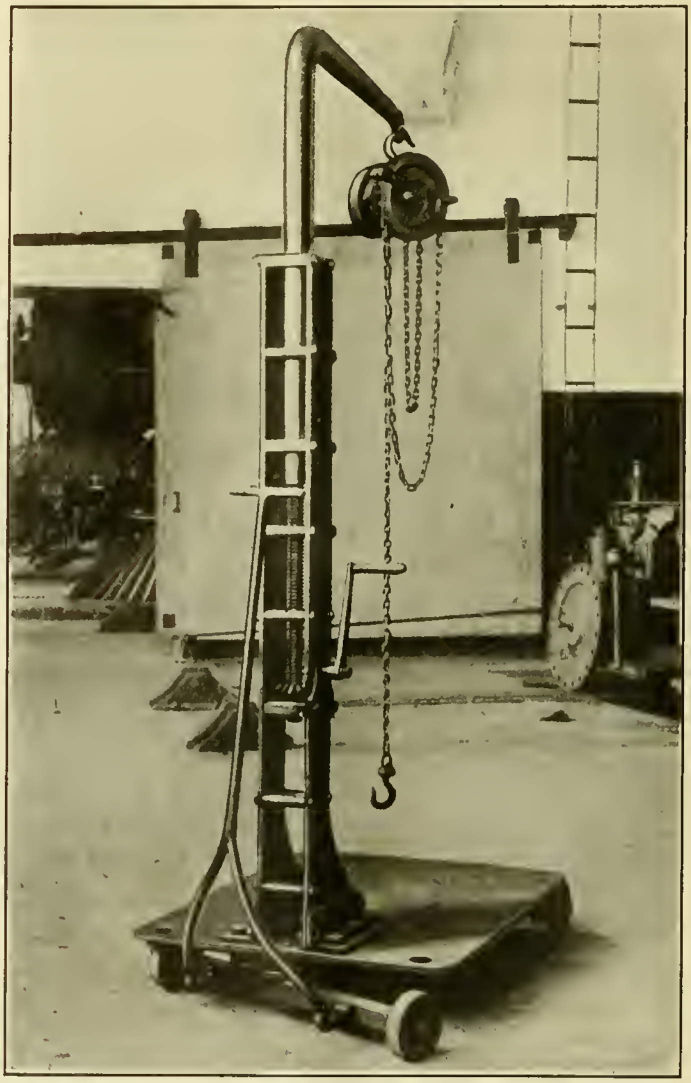
HOT WATER WINDOW WASHER USED AT ASHTABULA—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



ELECTRICALLY DRIVEN EMERY WHEEL IN AN ENGINE HOUSE.



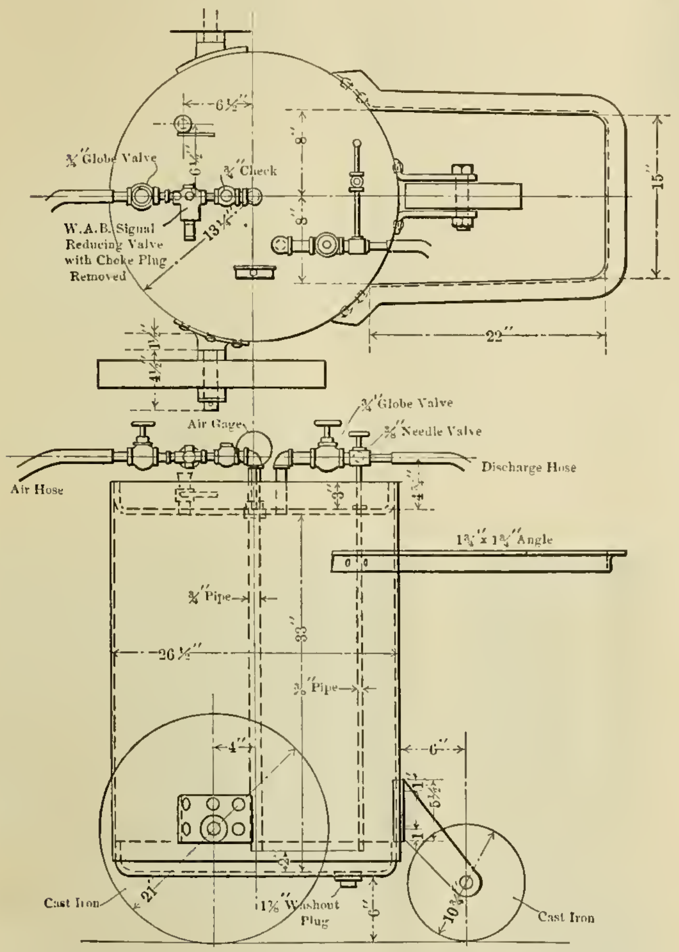
CRUDE OIL FIRING UP MACHINE, ASHTABULA ENGINE HOUSE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



PORTABLE CRANE FOR GENERAL WORK, WEST SPRINGFIELD ENGINE HOUSE—BOSTON & ALBANY RAILROAD.

Window Washer.—The importance of clean windows in a roundhouse can hardly be overestimated. Not only does it permit better work, but it has an indirect effect of increasing the self-respect and hence the ability of the workmen. The feeling of a man working in a roundhouse that is bright and clean and the manner in which he goes at his work is as much different from that obtained amid dirty, dark surroundings, as can be imagined. Washing off all of the windows in a large roundhouse is a big undertaking when the customary methods are used, and as it is impossible to estimate the results in dollars and cents, it is seldom that the expense is incurred of keeping the windows clean at all times, and they receive simply a periodical going over whenever a good opportunity offers.

The windows of the Ashtabula engine house on the Lake Shore & Michigan Southern Railway are always kept clean and this is accomplished by one man, whose entire time is devoted to it. He is able to obtain such excellent results largely by the



CRUDE OIL FIRING UP MACHINE, ASHTABULA ENGINE HOUSE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

use of a special swab and arrangement, which is shown in one of the illustrations. This consists first of two or three ordinary window swabs having different length handles, into the brush of which emerges a small copper pipe that is carried down the handle and having a valve at the lower end, is connected to a hose, that in turn is fastened to the hot water line of the boiler washing system. The warm water then is discharged through the brush and the windows can be quickly swabbed and rinsed without it being necessary to lower the brush to the floor.

Water running down the sash would collect in pools on the floor and form steam on the steam pipes if they are along the outer wall, and to eliminate this trouble a galvanized iron trough is provided that sets underneath and inside of the lower sash, being arranged to hook into place, and all of the water coming down the window is caught and discharged underneath the sash outside of the house.

An arrangement of this kind cannot be complimented too highly, and the results obtained far more than justify any expense incurred.

Emery Wheel in a Roundhouse.—One of the illustrations shows an electrically driven double emery wheel which is located between two of the pits in one of the sections of the Ashtabula enginehouse. This emery wheel is kept constantly in motion and an attempt is made, as far as possible, to locate locomotives which require repairs to the front end netting or diaphragm in this section. The emery wheel is largely used for grinding diaphragm plates, bolt heads, the ends of bolts and work of this character, which in most places necessitates the workman going to the machine shop. It is, of course, useful also for men working on other parts of the locomotive.

Near by it are located a small hand punch and a small shear, both sufficiently powerful to work on one-quarter inch plates. The store of plates and nettings is maintained alongside the fire wall in the same section of the house.

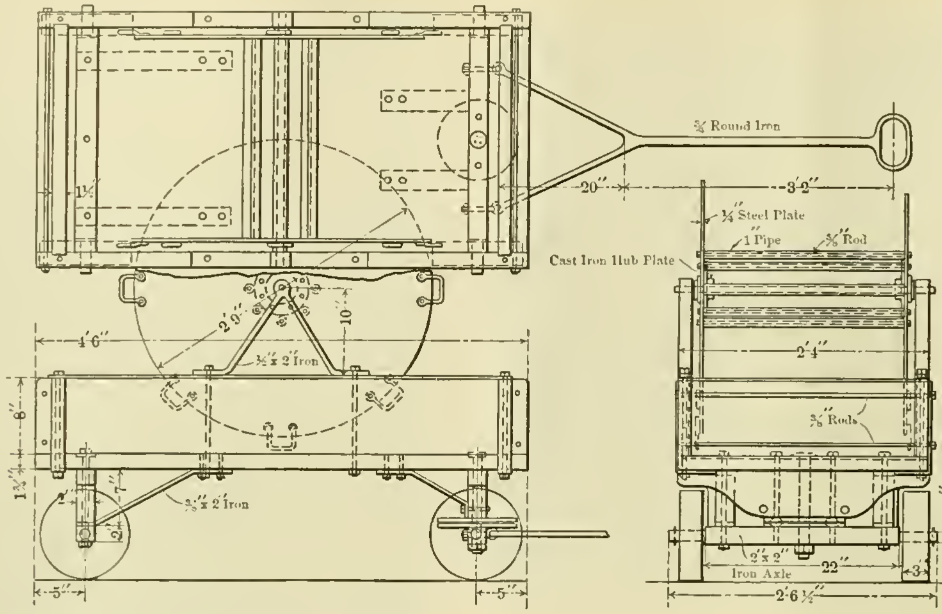
In practice it is found that both wheels of this grinder are in almost constant service and many parts are quickly ground which under other circumstances would be slowly cut with a cold chisel.

Firing Up Machine.—Firing up with crude oil is becoming quite general on a number of roads. This is usually done by soaking waste in oil and throwing it in on top of a light layer of coal in the firebox or by pouring the oil on top of the coal direct and lighting it. Both of these methods require the use of considerable oil and for the purpose of reducing this consumption and also for reducing the time for igniting the coal in the firebox a machine is in use at the Ashtabula engine house of the Lake Shore & Michigan Southern Railway and is shown in two of the illustrations. This consists of a large tank mounted on wheels, to be easily transportable around the house, which is filled with crude oil. Air pressure is carried to the bottom of the tank through a ¾-in. pipe and the mixture of air and oil is forced out through a discharge hose, the main connection being made at the top of the tank; this is supplemented by a connection through a ⅜-in. pipe which extends to the bottom of the tank and connects into the discharge line through a needle valve. This mixture of air and crude oil is then carried through a long flexible hose at the other end of which is connected a small pipe of a length which will reach to the front end of the firebox, the man handling it being on the deck plate. The end of this pipe has a small T and a number of small openings and the air and oil mixture under pressure discharging at the end is ignited and, being swept over the shallow bed of coal on top of the grate, quickly ignites it in all parts. About five minutes' work with this machine will start a glowing fire over the whole section of a large grate with the use of about one-half of the oil that would otherwise be required and in less than one-quarter of the time.

When a machine of this kind is used one man and his helper are able to fire up all of the locomotives at a large terminal, unless it is the practice to dump the fires on all engines coming into the house, in which case another machine would be required.

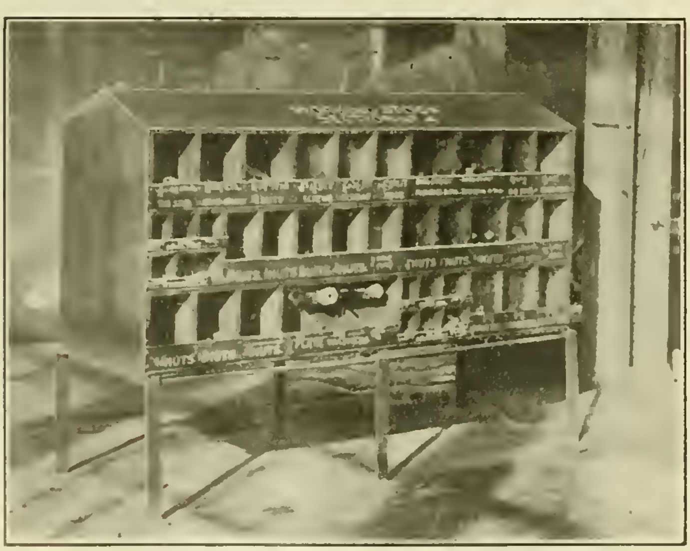
Portable Crane for General Work.—Most modern roundhouses are equipped with one or more portable cranes for handling cylinder heads, pistons, main rod ends and other heavy parts below the running board. A particularly well designed crane of this type, which is in use at the West Springfield engine house of the Boston & Albany Railroad, is shown in the illustration. This differs from most other designs in that the arm of the crane can be raised and lowered a distance of two feet, permitting it to have a maximum hoist and still go underneath the running board of practically any design of engine; in fact, it permits the arm to be projected into almost any place around the running gear.

The construction is simple, consisting of a broad cart on small wheels, the front axle being pivoted and provided with a handle. Five-eighth inch boiler plate is used as the bed. At the forward end of this are two uprights of boiler plate secured together by bolts with pipe spacers. At the top of this stationary



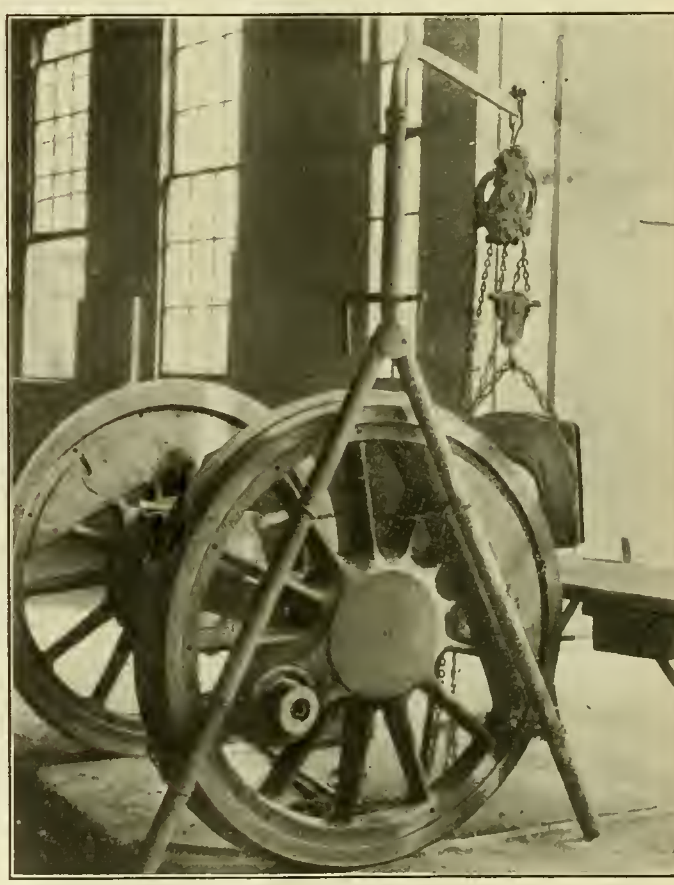
REEL AND CART FOR BOILER WASHERS, EAST BUFFALO ENGINE HOUSE—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

HOSE REEL AND BOILER WASHERS' CART, EAST BUFFALO ENGINE HOUSE—NEW YORN CENTRAL & HUDSON RIVER RAILROAD.



RACK FOR BOLTS, NUTS, WASHERS, ETC., AT THE EAST ALTOONA ENGINE HOUSE—PENNSYLVANIA RAILROAD.

post is a heavy plate with a hole through which the pipe crane arm passes. Similar plates guide the lower end of the arm and the screw. The arm is made of a piece of heavy Shelby steel tubing bent over at the top and equipped with a ring at the outer end into which a chain hoist is hooked. The lower end of the tube is plugged with a block into which a steel screw is threaded. This screw carries at its lower end a beveled gear meshing with a gear fastened to the handle shaft, the handle being alongside the stationary post. In this manner the arm is raised and lowered by turning the screw, and any adjustment



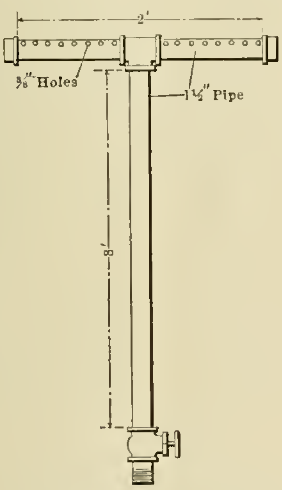
PORTABLE CRANE FOR LIFTING DRIVING BOXES, WEST SPRINGFIELD ENGINE HOUSE—BOSTON & ALBANY RAILROAD.

within two feet is easily obtained. The crane arm can be swung relative to the carriage through an arc of 90 degs., but a pin is fitted into its lower end which prevents its swinging in a complete circle. This makes it unnecessary to hold the arm when it is being raised.

The crane shown in the illustration has been tested with a 1,600 pound load without failure.

Boiler Washer's Cart.—It is not of any particular benefit to boiler washer's hose, which in any case is subject to very hard usage, to drag it over the floor of the house where it often gets caught and torn, nor is it a matter of economy to have the boiler washers chasing from one place to another until they can get their wrenches, nozzles, hooks, etc., all collected at one point. To eliminate this bad practice most of the roundhouses on the New York Central Lines are provided with a boiler washer's cart, the details of which are shown in one of the illustrations. This cart has a substantial body in which wrenches, nozzles, wires, torches, etc., are stowed, and has a large reel on which the hose can be quickly and easily rolled, not only keeping it from the floor, but also assuring that it is well drained. The cart and reel are of the home-made type, and can easily be put together in any shop.

Brick Arch Cooler.—It is often necessary for boiler makers to go into the fire box of locomotives fitted with brick arches shortly after they arrive in the house, for the purpose of rolling the flues. The arch, of course, retains its high temperature for a long time and, unless it is cooled off in some manner, makes it a physical impossibility for the men to work on it. It is expensive to remove the arch every time a few flues need rolling, and hence it has become customary at many points to cool the



BRICK ARCH COOLER.

arch with warm water and a simple cooling device which is used for this purpose at the Rensselaer roundhouse of the Boston & Albany Railroad, is shown in one of the illustrations. This is made up of pipes and pipe fittings forming a T, the cross being about two feet long, and having a number of three-eighth inch holes drilled in it. The ends are capped. The stem is about eight feet long, so that it can be put in through the fire door and have the valve at its end outside the fire box. This is connected to the hot or cold water line and the water is allowed to run over the arch until it is cooled off.

Crane for Driving Boxes.—At one round house a very handy small crane for lifting driving boxes from the axles after the wheels have been removed from the locomotive by means of the drop pit, is in use. The accompanying illustration shows its features and general construction. The vertical section of the legs is made of 2 inch pipe and the arm section of 1½ inch extra heavy pipe flattened down at the outer end. This sets down into the 2 inch pipe, a cup being driven into the latter to form a bearing for the bottom of the arm, which is simply slipped into place. One leg is hinged so as to fold up and by removing the arm the whole crane can be easily carried by one man to any point. It is but the work of a moment to set it into place alongside the wheel, the lower legs being chained to the spokes and the chain fall being hung on a hook at the end of the arm. On very large wheels a dog is provided for resting against the tire to relieve the strain on the upright. The arm is free to swing in either direction and the box after being lifted from the axle by the chain fall can be lowered to a bench, or floor within the gauge of the wheels. The crane shown in the photograph has been tested with a 700 pound weight without damage.

Rack for Nuts, Washers, Studs, Bolts, etc.—An arrangement which is most successful as a time saver is in use at the East Altoona engine house of the Pennsylvania Railroad. It consists of a covered rack with proper size pigeon holes built of wood and mounted on strap iron legs, so as to clear the floor by a foot or more, in which are kept a very complete supply of standard nuts, washers of various sizes, stud bolts, cotter pins, carriage bolts and other bolts for use by the roundhouse forces as required. There is one of these racks every seven or eight stalls located alongside of the post on the outer circle, all of which are kept well stocked. This material is drawn from the storehouse on a blanket order and used by the workmen without further record. The sweepers return all good material of this character that is picked up on the floor to its proper place in these racks. This simple scheme saves in the aggregate an enormous amount of travel by the workmen of a busy roundhouse. One of the illustrations shows the appearance of the rack.

LOCOMOTIVE TERMINALS.

To the Editor:—

In the article on "Locomotive Terminals" in your February number, in connection with the paragraph on "Design of Locomotive," page 49, you refer to the large dump grates in both ends of the firebox, which are of great assistance in cleaning clinkery fires; this matter has been thrashed out by the mechanical men of the country, and about 75 per cent. of them believe that a dump grate is not necessary, and I imagine there are very few but what are of the opinion that a dump grate next to the flue sheet is a prime factor in the leaky flue question, both because of the amount of dead ashes and dirt that is carried there, and the impossibility of shaking the grate with the rest of the grates.

Referring to mechanical coal docks; at some of these it is possible to screen the coal by drilling large holes in the apron on the horizontal trough over which the conveyor pulls the coal before depositing it in the bins; the slack coal going down through the holes, and the conveyor pulling the remaining lumps to the opening over the bin in which the coal is supposed to be dumped. Of course, this means that the bin next to the elevator would be for slack. This is a point that you probably have not noticed, and I believe one worth mentioning.

Master Mechanic.

Bronze Trimmings on the Santa Fé.—An order recently issued by the Atchison, Topeka & Santa Fé will result in every car and coach on the system being sent to the shops and the brass trimmings will give way to those of a statuary bronze. The hat racks, side rods, light fixtures and every piece of brass will be taken out or covered with a coat of bronze. This will do away with the constant expense of polishing and keeping it in shape. Bronze will hold its color unaffected by the elements, and will never grow dull and distasteful to the eye. A little cleaning now and then for sanitary purposes is all that is necessary.—*Railway and Engineering Review.*

International Master Boilermakers' Association.—The annual convention of the International Master Boilermakers' Association will be held at the new Clifton hotel, Niagara Falls, Ont., May 24-27, 1910.

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

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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

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CONTENTS

* Denotes illustrated article.

With this issue R. V. Wright leaves the AMERICAN ENGINEER AND RAILROAD JOURNAL to join the editorial staff of the *Railway Age Gazette.*

While the officers and staff of this journal sincerely regret the severing of a most pleasant relationship, they feel that, in view of the opportunities offered by a weekly publication in the general railroad field to a man of Mr. Wright's calibre, congratulations are to be extended to both him and to our contemporary on the new relationship.

Mr. Wright's work on this journal during the past five years needs no reviewing. Its uniformally high character is generally known and universally praised by those who have followed it carefully.

ELECTRIFICATION OF TRUNK LINES.

A president of a Western railroad has this interesting comment to make on Mr. Pomeroy's article on "The Electrification of Trunk Lines," which appeared in the February number of this journal:

"This is the first really practical exposition that I have seen on this very important subject and I am satisfied that a careful study of the article by the managers of the railways will save a great deal of the stockholders' money. The concluding paragraph of your article should be adopted as a railroad classic and should be given the widest possible distribution, with the idea of attempting, at least, to bring back to reason some of the violent agitators who pose as public servants, both in our State and National legislatures."

Our readers may be interested in knowing that Mr. Pomeroy's paper is to be presented at a joint meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers at Birmingham, England, next July.

INDUSTRIAL EDUCATION.

The Industrial and Trades School Act, adopted by the legislature of New York in 1908, has greatly increased the interest in industrial education in that State. The industrial and trades school law in the State provides for *industrial schools* for boys and girls who have reached the age of 14, and *trades schools* for pupils who have reached the age of 16. In other words, the Education Department is standing for two types of schools: (1) the "vocational school," "intermediate industrial school," or "industrial school" which will give better elementary school provision for the vocational needs of those likely to enter industrial pursuits; (2) "preparatory trades school," "preapprenticeship school" or "trades school" which offer special shop, laboratory and drawing room practice along a *chosen trade* pursuit. By vocational education is meant all that training and instruction which purposely ministers to self-support and productive capacity.

A special committee of the American Federation of Labor appointed to examine into the work being done by the State Education Department of New York reported at the Toronto convention in November, 1909. Part of the report is as follows:

"If the American workman is to maintain the high standard of efficiency, the boys and girls of the country must have an opportunity to acquire educated hands and brains such as may enable them to earn a living in a self-selected vocation, and acquire an intelligent understanding of the duties of good citizenship.

"We favor the establishment of schools in connection with the public school system, at which pupils between the ages of 14 and 16 may be taught the principles of the trades, not necessarily in separate buildings, but in separate schools adapted to this particular education, and by competent and trained teachers.

"The course of instruction in such a school should be English, mathematics, physics, chemistry, elementary mechanics, and drawing; the shop instruction for particular trades, and for each trade represented, the drawing, mathematics, mechanics, physical and biological science applicable to the trade, the history of that trade, and a sound system of economics, including and emphasizing the philosophy of collective bargaining.

"In order to keep such schools in close touch with the trades, there should be local advisory boards, including representatives of the industries, employers and organized labor.

"The committee recommends that any technical education of the workers in trade and industry being a public necessity, it should not be a private but a public function, conducted by the public and the expense involved at public cost.

"There is a strong reaction coming in general methods of education, and that growing feeling, which is gaining rapidly in strength, that the human element must be recognized, can not be so disregarded as to make the future workers mere automatic machines.

"Experience has shown that manual training school teachers without actual trade experience, do not and cannot successfully solve this great problem, and that progress will necessarily be slow, as new teachers must be provided, a new set of textbooks will have to be written, and the subjects taught in a sympathetic and systematic manner."

* * * * * * *

J. Shirley Eaton has prepared a treatise on railway education which has been published as Bulletin No. 10, 1909, by the United States Bureau of Education. Mr. Eaton has collected information of everything important that is being done in the matter of educating railway employees in all departments; the mechanical department, or course, receives a large amount of attention, as more has probably been done in this department along these lines than in any other.

Mr. Eaton has made a number of valuable suggestions as to the best methods and principles to follow and his study should be in the hands of all officials who are interested in improving the efficiency of railway employees.

Among Mr. Eaton's conclusions are the following:

"Railways should extend the principles of definite apprenticeship to every department of the service, and should provide for two or more grades of apprentices in order to take account of differences in capacity and work done elsewhere, either in properly accredited schools or by experience, and leading to different grades of service.

"There should be formal provision for movement among departments under proper conditions, and the comity of railways should be so far extended as formally to provide for some interchange of officials under special restrictions.

"Efficiency should be recognized by an efficiency wage, stated distinctly apart from the seniority wage."

THE CANADIAN PACIFIC RAILWAY MALLET ARTICULATED LOCOMOTIVE.

Mr. Vaughan's new design of Mallet articulated locomotive has some original features which promise to prove very successful, as indicated by the preliminary tests which have been made of this engine, described in the opening article of this issue. The arrangement of the cylinders, both pairs of which are brought near together at about the middle of the locomotive, is new on this continent, although it has been used to some extent in France. This arrangement simplifies the construction and practically eliminates the possibility of leakage from the steam pipes, and also makes it possible to reduce the overall length of the engine to a minimum.

The superheater adds to both the economy and capacity of the locomotive. This feature should not be regarded as experimental, for it differs only in its method of application from the superheaters in general use on the Canadian Pacific Railway, which have been giving such successful results during the past few years.

Additional details of this interesting locomotive will be described in our next issue.

METHODS OF SUPERVISING MATERIAL COMPARED WITH METHODS OF SUPERVISING LABOR.

The material in a machine or structure is watched much more carefully than the labor.

Specifications describe in detail the quality of material wanted, and careful inspection insures the delivery of the grade specified. Detailed drawings planned by engineers and executed by skilled draftsmen show in complete detail the size, kind and shape of each piece. Buying is carried on by purchasing departments and orders placed for such quantities and lots that there will be a minimum of waste in using the material. The material after purchase is put in the hands of a store department, which keeps it under lock and key, only turning it over to the foreman when he states what quantity he wants and for what purpose. All this shows how carefully the material is planned for, bought, and watched over. The most brilliant talent of the organization is employed in this work.

A simple structure or machine is not built until complete plans are made as to sizes, kind and quality of material. The blueprint or shop drawing shows all these details. The shop foreman is required to follow the drawings completely. He gets his material from the store department, which in conjunction with the purchasing department has already accumulated from the same drawing the necessary stock. The foreman has nothing to do as to kind, quality or quantity of material. It is merely his duty to follow the plan or blue-print.

The labor that is to go into the finished structure or machine has not been planned for in the least. The gang of workmen to perform the job is turned over to the foreman, who has a free hand in directing when and how each necessary operation, that enters into the finished article, shall be done; yet in the average railroad shop the cost of labor is greater than that for material.

The usual process when a job is commenced is that there is a rush to get every man at work and from that instant the foreman's duties become one series of emergency moves to get out of difficulties that arise because no move has been planned ahead. Each worker or gang is moved along as best possible, doing what seems the most important thing at the minute, but directed by one who has neither the means nor the ability to see the work as a complete unit. The foreman or boss is busy driving those men or gangs that are not keeping up with the most advanced, and the advanced gangs are loafing or appearing to keep busy while waiting for the laggards to bring up the rear.

We use the best talent to direct the use of the material used by these gangs, but we leave the direction of when and how these gangs shall work to the ordinary gang boss who has not the training or ability to plan ahead. He takes the greatest pride and delight in his ability to get out of difficulties which, if a little planning ahead had been done, would not have occurred.

Material would be wasted if the drawing had not been made first. No plan of the labor is made first. Is not the waste of labor fully as great as that of material if we tried to build leaving the entire matter of material to the foreman as we do the matter of labor?

Running a shop or other organization is like a checker or chess game. The foreman is expected to play this game by getting the work past certain machines, men and gangs, at the same time advancing the work as a unit. This foreman is given nothing to help him see the whole shop at once. His leg capacity is usually the limit of his ability, for he must walk from machine to machine, gang to gang, and is only able to see the one part of his shop immediately in front of his eyes at one time. It would be a poor checker player who could only see one square ahead and in addition lost sight of all blocks except the one his hand was on at the time of making a move.

No one can carry the complete standing of all work even in a small shop in his head, much less see all the finer points of the game compared with all the possible moves. Yet is this not about the thing we expect of our foremen and superintendents? They, as a rule, are not men to figure and plan ahead. Can we expect them to do so any more than we can expect them to be draftsmen, storekeepers or purchasing agents? This part of the game should be left to a separate department which will plan the time, sequence, and method of each move as definitely as the draftsman has planned sizes and shapes of material.

In the organizations of early industrial history the foreman or man on the work had the matter of material as completely in his control as the same man now has the matter of labor. He believed he was the only one who knew what kind and how much to use. He put up a vigorous kick in his way when he was relieved of this part of his duties, for, to quote a present day foreman, "Was he not right onto his job and didn't he know better than any one else what was wanted?" We are better off for our purchasing, store and draughting departments, for foremen are doing better work with better materials, fewer false moves, and less waste.

The next step in the advancement of industrial organization is a department which will plan ahead each move to be made by the workmen in as complete detail as our present blue-prints describe the use of material. The foreman's duties will be to follow these instructions as to labor with the same degree of exactness with which he now follows his blue-prints.

This department will be as separate from direct contact with the men and the shop as the present drawing room is. It will also be looked upon with ridicule by the present day foreman, but the future manager who has such a department installed as part of his organization will no more return to present methods than the present manager would do away with his efficient store, purchasing and draughting departments.

THE UNIT SYSTEM OF ORGANIZATION†

Major Charles Hine.*

The primary object of this paper is to explain the details of the unit system of organization that is being installed on the Harriman Lines under the direction of Julius Kruttschnitt, director of maintenance and operation, Union Pacific System—Southern Pacific Company. It is not desired so much to theorize as to what might, could, would or should be done, but rather to narrate what has been accomplished in actual practice.

An essential feature of the system for each unit is a senior assistant, who, ranking next to the head of the unit, remains in charge of the headquarters' offices and acts as executive officer. This senior assistant is supposed to see, with common sense exceptions, all of the incoming and outgoing mail. If the other assistants are present at headquarters, they sign their own mail before it passes over the desk of the senior assistant for the latter's information. If an assistant is absent from headquarters he is represented, not by a chief clerk, but by a man of the wider experience of the senior assistant who signs the routine mail in his own name. The absent assistant is advised of the action taken by such methods as common sense and courtesy may suggest. Matters highly technical are held for the return of the assistant who is a specialist in that line.

The most difficult task in any organization of human endeavor is to correlate the activities of the workers on the outside with the necessary requirements of correspondence, records and accounting on the inside. The artisan in the shop, the traveling salesman on the road, the soldier in the field, the sailor at sea, the railroad man on the line, all have their troubles with the man in the office. When the inside man knows the outside game at first hand such differences in points of view are minimized, friction avoided, and therefore money saved. Railway operation is the most exacting of human tasks. Like the conduct of a household, a farm, a hotel or ship, it is a continuous performance. Unlike those exacting occupations it must maintain its own communications over hundreds or thousands of miles of territory. So complex is its administration that chances should not be taken of losing money through half baked decisions of partially trained office occupants. Most railway officials flatter themselves that when on the line they maintain a grasp on the office. Yet every hour in their absence action must be taken on matters which, apparently trivial in themselves, have far reaching results. This statement is not a reflection upon the splendid ability and earnestness of railway officials. It is merely a recognition of the fact that a man can be in only one place at a time; that there are only 24 hours in the day and only 365 days in the year. The salary of one official is negligible as a percentage of the operating cost of the average unit. Accordingly the system insists that the second best man of the unit, with practical outside training, shall stay at headquarters and sit on the lid. In some cases it has been found necessary to appoint another official to perform the previous outside duties of the senior assistant. In other cases it has been found that the outside work could be divided up among other members of the staff.

In any system of organization the most important unit is the individual. It is claimed that when one man signs the name of another the first by so much loses initiative and individuality. A man's name is his birthright, his signature his patent of enlightened manhood. Long habit on railways has perhaps minimized the pernicious effect of unconsciously building up one individual at the expense of many. Such industrial feudalism, however, can no more permanently endure than did the feudal serfdom of the middle ages. The unit system, therefore, insists that every man shall transact the company's business in his own name. There is nothing new in this. The whole system is really an extended application of the simple principles of train dispatching. A train order is addressed impersonally "Conductor and Engineman." Where proper discipline obtains the signatures to the orders are genuine. When the oldest conductor lays off the youngest extra man does not sign the former's name to orders and reports. Addresses in official matters should be impersonal because of the possible difficulty of identification; because of the resulting elasticity in interior administration. One does not ordinarily address a letter to an individual attaché of a firm, a bank, a hotel or a newspaper. He does not normally attempt to dictate who shall handle his communication. He leaves that to the intelligence and discretion of the organization that he is addressing. Under the unit system communications are addressed to the office—except when personal. The action taken, however, is by a real live man, whose identity is not concealed. The position is assumed that the recipient of a communication has the right to know what person is responsible therefor. The principle is established that except for a strictly personal staff, as for example a private secretary, all persons report ordinarily to a headquarters or an office and not to an individual. The authority of such headquarters or office is always exercised by an individual. Authority, in an enlightened organization of society or industry, should be impersonal. Its exercise is highly personal.

* Special Representative, Union Pacific System—Southern Pacific Company.

† A paper presented at the January meeting of the Western Railroad Club.

The application of the above established principle to the reorganization of an operating division requires that the assistant superintendent shall become the senior assistant. If previously there is no assistant superintendent the trainmaster, or most probable successor of the superintendent, becomes the senior assistant.

The next step in making the division a complete unit with its head, the superintendent, in effect general manager, is to move the division master mechanic and the traveling engineer (road foreman of engines) to the same building with the superintendent. The division shop as a sub-unit is left in charge of a general foreman. The old theory has been that a master mechanic if located at the shops can better supervise the shop forces. It is believed that the volume of business and complexity of modern conditions have outgrown this theory. It is found in practice that the master mechanic spends much of his time in an office near the shop writing letters to the superintendent, the superintendent of motive power and other officials. Again, human nature is such that the master mechanic so located may unconsciously dwell on the plane of the division shop foreman at the expense of the former's mechanical responsibilities along the road and at outlying terminals. When this results his value as a division official is diminished. The governing reason for locating the master mechanic and the traveling engineer with the superintendent is not only to gain a closer personal touch. Such contact is largely a matter of personal equation and of training regardless of location. The main object is to eliminate red tape by making possible a consolidation of files in one office of record. It has been demonstrated that relieved of a bureau of unnecessary correspondence the master mechanic can and does spend more hours among his men whether in shops, on the road, or at terminals.

Assuming that the division engineer, the trainmaster, and the chief dispatcher are already located in the same building with the superintendent, the division is ready for reorganization. The general superintendent and the instructor visit division head quarters where are assembled the division officials and their old chief clerks. In an informal lecture of two or three hours' duration the principles of the system and its unwritten laws are outlined. Explanations are given of the revised standard circular of organization, which reads as follows:

......................RAIL...... COMPANY.

.... DIVISION.

OFFICE OF SUPERINTENDENT.

CIRCULAR NO. ......

.... 191...

Effective .... 191.... this division discontinues among its officials the use of titles—master mechanic, division engineer, trainmaster, traveling engineer, and chief dispatcher.

The following named officials are designated:

1. Mr. E. F. ....Assistant Superintendent.
2. Mr. G. H. ....Assistant Superintendent.
3. Mr. J. K. ....Assistant Superintendent.
4. Mr. L. M. ....Assistant Superintendent.
5. Mr. N. O. ....Assistant Superintendent.
6. Mr. P. Q. ....Assistant Superintendent.

They will be obeyed and respected accordingly.

Each of the above named officials continues charged with the responsibilities heretofore devolving upon him, and in addition assumes such other duties as may from time to time be assigned.

Such of the above as are located in the same building have one consolidated office file in common with the superintendent.

All reports and communications on the company's business, originating on this division, intended for the superintendent, or for any assistant superintendent, should be addressed simply, "assistant superintendent" (telegrams "A. S."), no name being used unless the communication is intended to be personal rather than official, in which case it will be held unopened for the person addressed. It is intended that an assistant superintendent shall always be on duty in charge of the division headquarters offices during office hours. The designation of a particular assistant superintendent to handle specified classes of correspondence and telegrams is a matter concerning only this office. Each official transacts business in his own name, and no person should sign the name or initials of another. The principle to guide subordinate officials and employees is to be governed by the latest instructions issued and received.

Train orders will be given over the initials of the train dispatcher on duty.

The modifications of pre-existing organization and methods herein ordered have been carefully worked out to expedite the company's business by the reduction and simplification of correspondence and records. It is expected and believed that officials and employees will insure a successful outcome by lending their usual intelligent co-operation and hearty support.

Officials and other persons outside the jurisdiction of this division are requested to address official communications, intended for the superintendent or any assistant superintendent, "Superintendent, ... Division, ..." (telegrams "Supt."), without using the name of the superintendent except for personal matter.

C. D.,
Superintendent.

Approved:
A. B.,
General Superintendent.

It will be observed that no distinct grade of senior assistant is created. The unwritten law is that whatever assistant is assigned to the charge of the headquarters' office becomes the senior for the time being. It was originally intended that different assistants should be detailed as the senior for certain definite periods. In some cases such a rigid rule may be necessary. The experience of a year indicates that the incidents and casualties of the service may usually be depended upon to let the situation work itself out. This is gratifying, since in such matters self-suggesting procedure is preferable to rigid rules. For example, if an assistant sprains his ankle or mashes his foot the superintendent can assign him to the office and send the then office man out on the road. Vacations and enforced absences afford the superintendent an opportunity to cover the situation by a common sense assignment. On one division the senior assistant was necessarily absent for some weeks. The maintenance assistant who happened to be next in rank was busy outside relaying the division with new steel. The third man, the mechanical assistant, had few troubles of his own in summer, and to him fell the opportunity to be broadened by a tour in the office. The superintendent and the other assistants, including the old traveling engineer, did the engine chasing. No circular was necessary, and there was less confusion than if two dispatchers had exchanged tricks.

In order that their authority may not be restricted when meeting a given emergency it is necessary to give the division officials the uniform title of assistant superintendent, without the limiting effect of a descriptive phrase. If any one can coin titles that will describe duties and not, under railway customs, restrict authority, such titles will be welcome. When a vacancy occurs the circular states, "Mr. .... is appointed an assistant superintendent vice Mr. ...." His assignment to duty by the superintendent is verbal. If a superintendent should find himself with an assistant unfitted by temperament or experience to cope with a wider range of duties he could quietly restrict such assistant to a prescribed limit.

The assistant superintendents when at headquarters, except the senior assistant, have equal rank. On the road they have the relative rank indicated by the circular or the current working time table. In case two or more find themselves together and an interruption to traffic or other emergency requires, the highest on the list takes charge and becomes responsible. The system forces more officials to assume responsibility and by so much increases the protection to the company's interests. More and more is heard about "this division," and "the company" and less and less about "my department."

Most division officials have welcomed the title of assistant superintendent as a real promotion and as an increase in opportunity. Some still feel the loss of a distinctive title. Time alone will prove that railroading has become great enough as a profession to carry its own marks of distinction and to permit of a properly balanced specialization along the lines of greatest aptitude. Men like Julius Kruttschnitt, James McCrea, L. F. Loree, Epes Randolph, J. W. Kendrick, F. A. Delano and W. W. Atterbury, have not lost any reputation as civil and mechanical engineers because of their greater prominence as railway executives. For the same reason that a chief engineer blushingly accepts the title of vice-president, a division engineer should modestly aspire to the position of assistant superintendent. This is one of the features of the unit system that it will take a generation to work out. Eventually an official cannot hope to perform the duties of chief engineer, or superintendent of motive power, until he has had experience in the grade of division superintendent. When superintendents are selected from diversified sources this will be possible. An advantage of the uniform title of assistant superintendent is that, as in the case of vice-presidents, it necessitates speaking of a particular official by name. When any official is away from his headquarters, he is addressed by name.

The unit system makes a distinction between superior or co-ordinate units and subordinate units. Employees address "assistant superintendent." If they addressed "superintendent" there would be an implied obligation on the part of the superintendent to answer. If his personal action is desired he must be addressed by name. Even though "assistant superintendent" is addressed the reply may be signed by the superintendent himself. Subject always to his superior's wishes, the superintendent makes his own office rules as to what he shall personally handle. It is up to him to see all, a part, or nothing for a given period, just as he sees fit. Should the superintendent's letter call for further information from the employee, the latter's reply would still be addressed, "assistant superintendent." For all that the sender knows the particular official may be necessarily absent when the letter is received. Numerous old conductors have expressed their appreciation of the fact that a man knows what official has addressed him, and that it is no longer possible to be jacked up by a clerk using the name of an official.

Communications from superior or co-ordinate authority are addressed to the head of the unit, the superintendent. In his absence routine matters for higher or co-ordinate authority are signed by the senior assistant who appends to his own title the explanatory phrase, "For and in the absence of the superintendent." Going down on the division no such explanation is necessary, as the authority of any assistant superintendent carries over the division itself.

The superintendent being in effect general manager of his division is given charge of division stores as well as division shops. He must, therefore, obey the instructions of the general storekeeper as well as the superintendent of motive power. The general storekeper has thus placed at his disposal all the administrative machinery of the division. Instead of a lack of practical sympathy between the stores and the users of material, it is made the duty of the superintendent and the assistant superintendents to watch material costs as well as labor costs, to help keep down interest charge on stocks as well as overtime. A railway company harnesses the forces of nature, including its divinely human elements, for one purpose, the manufacture and sale of an intangible commodity, transportation. The more closely interwoven the constituent parts of production the more efficient and economical should be the output. When weaknesses develop, when education is needed as to the increased importance of a given element, the remedy is not necessarily the creation of a separate department. A general storekeeper there should be, whatever his title, technically expert in his important specialty, responsible to the general manager and in a position to insist upon efficiency to the extent even of ordering material moved in special trains when it is true economy for the company to do so.

It will be noted that the superintendent, as the representative of all so-called departments on his division, has about as many superiors as he has assistants. The work of these superiors is balanced by the general manager. The scheme will not be fully effective until the unit system is applied to the general offices, making the general superintendent, the chief engineer, the superintendent of motive power, the general storekeeper, the car service agent, the superintendent of telegraph, the signal engineer, and the superintendent of dining cars all assistant general managers with one consolidated office file, and their activities co-ordinated by a senior assistant general manager at headquarters. Thus far only one general office, that of the new Oregon & Washington Railroad at Seattle, has been reorganized in accordance with this conception.

The number of divisions now reorganized is twenty-one with eleven still to follow. The number of assistant superintendents on a division varies from three to twelve. Every superintendent has shown his ability to handle as many assistants as the management may give him. The most gratifying feature of the reorganization is the fact that in all cases the talent at hand has been sufficient. No importations have been necessary. The incumbents of official positions have responded splendidly to the confidence reposed in their ability. Some divisions have gone farther than others. This always has been and always will be the case. Every one, however, has made real progress, some of it unconscious. The human element has been recognized. Division officials who from lack of early breadth of opportunity have not the qualifications for senior assistant are not required to fill the position. Their services to the company have been too faithful to warrant humiliation or elimination. Their grasp of present conditions is greater than could be that of student successors. When, in the course of nature, a new crop of officials matures it will be ripened younger but attain a fuller growth.

Consideration has been shown for the clerical forces affected by the changes. No individual has had his salary cut. As vacancies occur through natural causes salaries are readjusted; some increased, some diminished to meet the new conditions. All of these matters are left to the local officials. Principles are enunciated, suggestions made, but responsibility for details is left to the officials on the ground. The system means more officials and eventually fewer clerks. Probably by a cheese paring effort enough clerks could be eliminated to offset such increases in official salary lists as have been found necessary. The management has felt that increased supervision will warrant the outlay. This liberal policy is justified by good business sense rather than by the prosperity of the Harriman Lines. The poorer a road the more money it should spend for supervision and the development of esprit de corps.

Formerly office work was grouped around officials. This resulted in petty principalities and bureaucratic administration. By tearing down some office partitions there were razed those figurative department walls, which so often operate to keep in the man who is trying to keep the other fellow out. Under the new conception the work is grouped by classes. The technical term among business experts is "The concentration and co-ordination of routine and related processes." At a small roundhouse a handy man may be machinist, boiler maker and car repairer. In a large shop for obvious reasons the boiler makers and machinists are segregated. So, in an office, stenographers may be pooled, accountants segregated and clerks concentrated for the general good of the office work rather than for the fancied importance of a particular phase. The key to success in the unit system is a properly handled file room. It is given preferred attention and whatever force is necessary. When all of the clerks of the division are pooled no difficulty is experienced in finding sufficient to handle the file room. William's Railroad Classification is being installed with a view to uniform filing over the Harriman Lines.

As a general proposition officials at headquarters should not exchange written communications among themselves. Superintendents must apply this principle without hard and fast rules. For example, the superintendent of a heavy division being on the line some 200 miles from headquarters, very properly addressed a joint letter to each of his ten assistants, calling their attention to a wreck he had just picked up and as the lesson to be learned enjoining upon them a vigilant enforcement of certain rules. It has been found possible to reduce the correspondence of divisions reorganized from 30 to 50 per cent. Even with reduced clerical forces night and Sunday office work have been eliminated. The great reduction is made possible by the constant presence of the senior assistant who is alert to discourage the letter writing propensities of headquarters. It is expected that when all of the units under the Chicago office are reorganized there will be a net saving of at least 500,000 letters per year. Every letter costs a few cents to produce. Its retarding effect upon administration cannot be measured in money. Its dwarfing influence upon the individual initiative of the man below is likewise indeterminate. It is expected also that when the reorganization is completed numerous routine reports can be dispensed with.

It is not expected that a mere change of title or an assignment by a superintendent will make a man a skilled mechanic or an experienced engineer. For technical questions arising on a division the most expert knowledge available will continue to be utilized. It is claimed, however, that as the average division official has been in the service at least ten or fifteen years, he cannot fail to have acquired some familiarity with the requirements of the various branches of the work. The old trainmaster may as third trick dispatcher have ordered an engine taken down and towed in without awakening the master mechanic. By so much more should he with wider experience be able to say whether or not the company's interests are being best observed in the handling of a locomotive that may happen to come under his notice. The mechanical assistant cannot be everywhere and any help that his fellow officials can render the company should receive. Conflict of authority is avoided by the common sense and courtesy of the assistants and by the attention of the superintendent. Nothing makes men so conservative as responsibility. It is claimed that the superintendent on the ground is better able to decide these questions intelligently than is a hard and fast code formulated by a man behind a distant desk. What is construction to-day will be maintenance to-morrow. What is motive power at the turntable becomes transportation at the switch.

Each official continues responsible for his branch of the work until otherwise indicated by the superintendent. The maintenance assistant is not allowed to plead transportation duties as an excuse for defective track. With him track must come first. When the train stops he cannot inspect track until it resumes. Meantime he may be able to minimize the delay by seeing that employees perform their duties promptly. He is not allowed, except for insubordination, to discharge employees on another assistant's payroll. He is expected, however, tactfully and politely but forcefully, to insist that the rules be obeyed. The faithful old employees need only encouragement to perform their duties well. The young and inexperienced require constant supervision and instruction. Due to its great extent of territory a railway exercises less control over its employees than any other line of organized effort. The safety of lives and property demands the greatest possible intelligent supervision.

Adaptability to changed conditions is largely a matter of temperament. Among his intimates one can usually predict in advance what position a particular person will take on a question of politics, religion or organization. Some men believe in an early convergence of authority, in wide latitude of discretion. Others believe that the best results are obtained by postponing decisions until the highest possible authority is reached. On important questions there are usually two schools of opinion. Nearly every civilized country has two great political parties. On the railways of America there will always be diversity of opinions and practices as to the organization of forces. The executive officers of the Harriman Lines have felt that the individual will be broadened and the service correspondingly improved by the introduction of the elastic methods herein outlined. While many are enthusiastic, not all of the persons affected are convinced. It is to the credit of the latter that in spite of honest doubts all have contributed more or less to the success of the scheme. The work is being kept on a high plane, guided by those exalted ideals of duty; freedom from personalities, and the good of the service.

Some people evidently think that because the air brake is automatic and will "work itself," it should also "take care of itself."—*The Air Brake Magazine.*

USE OF AIR PUMP EXHAUST FOR HEATING FEED WATER.

The use of air pump exhaust for heating the tank water will effect a considerable saving. With a feed water temperature of 34 degrees it takes 1,198 heat units to convert the water into steam at 200 lbs. gauge pressure, but if the same feed water has been previously heated to 100 degrees, it requires only 1,132 heat units to accomplish the same result. Or, a saving of 5.5 per cent. is effected by heating the feed water to 100 degrees.

On some tests made in January, 1907, the average feed water temperature was 37 degrees, while those made in June on the same run on the ——— division had an average feed water temperature of 58 degrees. During July on the ——— division we obtained an average feed water temperature of 71 degrees. Therefore, it would seem reasonable to assume that for the entire system and for the entire year the average temperature of the water put in the engine tank is probably in the neighborhood of 55 degrees, or, in other words, this feed water is 45 degrees lower in temperature than it can safely be put into the injector.

Assuming that the steam delivered to the air pump and exhausted into the tank has, by the time it reaches the tank, dropped from 1,200 heat units to 1,000 heat units (which allows for loss of heat due to condensation and work done in the air pump), one pound of this value would raise 15 lbs. of water from 34 to 100 degrees. Or, in other words, if 6 2/3 of the total steam generated passed through the air pump and was exhausted into the tank, the entire amount of feed water would be raised from 34 to 100 degrees.

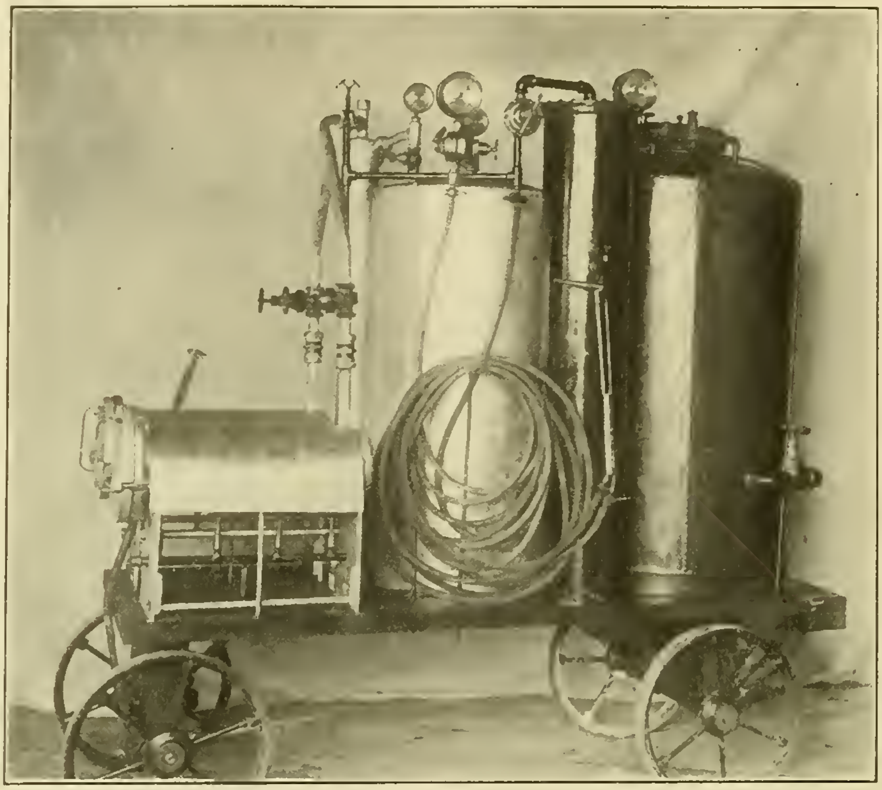
In looking over some tests made on freight trains and on passenger trains over the same division, I find that 5.3 per cent. of the total steam generated was used for operating the air pump on the freight runs, and on the passenger runs 1.9 per cent. of the total steam generated was used by the air pump. The freight runs were made on through trains making few stops and with comparatively little dead time, and the passenger trains were high speed, making only about six stops per trip.

It is then reasonable to assume that for the entire system probably four per cent. of the steam generated in the locomotive is used by the air pump, which means that four per cent. of the coal bill is chargeable to it; but a great percentage of the heat in the steam used by the air pump can be reclaimed by using the exhaust steam from it for heating the tank water. Under severe weather conditions there would probably not be enough exhaust steam to bring the feed water temperature to 100 degrees until the tank was about half empty.

It is believed that an average saving of 2½ per cent. can be made by the intelligent use of the air pump exhaust for heating the tank water.—*From a fuel engineer's notebook.*

Accidents Reduced by Pay-as-you-enter Cars in Chicago.—The Chicago City Railway has compiled comparative statistics of accidents before and after the introduction of pay-as-you-enter cars on its principal lines. Comparing the period from Nov. 24, 1906, to Jan. 31, 1908, which included but two months' operation of pay-as-you-enter cars on one line only, with the period from Nov. 24, 1907, to Jan. 31, 1909, during which pay-as-you-enter cars were in service on all trunk lines, the number of boarding and alighting accidents, accidents due to falling while the cars were rounding curves and accidents to persons stealing rides on cars was reduced 31.9 per cent.—*Electric Railway Journal.*

Engineering.—Engineering is applied science, and its application is directed, in ninety-nine cases out of a hundred, to just one thing—*to making money for somebody.* No quality will be found of greater value to the engineer than commercial acumen. The young man who looks upon engineering *purely* as a science, or as the art of applying a science, independent of business principles, will very likely remain a drudge all his life, directed by men of far less scientific ability, but of greater business acumen. —*George Fillmore Swain of Harvard University.*



PORTABLE OXY-ACETYLENE WELDING OUTFIT.

OXY-ACETYLENE WELDING.

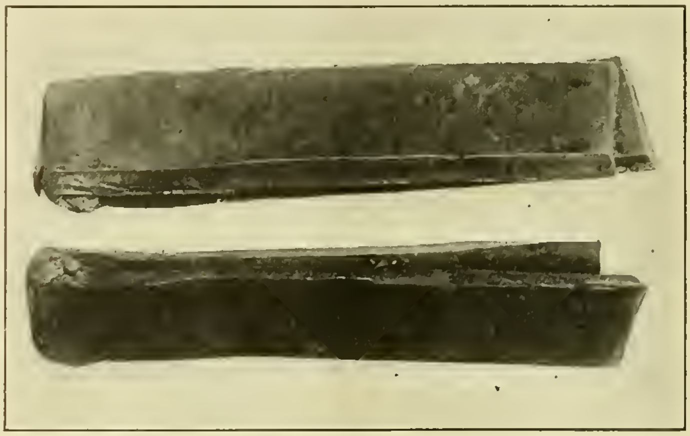
A difficult job in repairing the flue sheet of a locomotive firebox, by means of the oxy-acetylene welding process, is shown in the illustrations. The part which was cut away had been badly cracked and repaired by small patches and screw plugs. The new patch, of a very irregular shape, was cut out and fitted by means of the cutting attachment of the welding machine. An effort was made to expand the sheet with gas torches and thus neutralize the stresses due to contraction, but this did not work out successfully and the weld was cracked for a considerable distance at its ends.

A DIFFICULT JOB IN WELDING. THE FIVE SPOKES WERE SUCCESSFULLY WELDED BY THE OXY-ACETYLENE PROCESS.

The sheet was then preheated locally and annealed with satisfactory results; the engine has been in service for some time since the weld was made, and is in first-class condition. The seam was approximately three feet long. It is an example of one of the most difficult pieces of work since it embraces a horizontal seam, which is difficult because of the possibility of laps or "cold shuts" at the upper edge of the weld; also the inverted weld which is very slow, yet is free from laps, since the metal that remains there is quite sure to be welded.

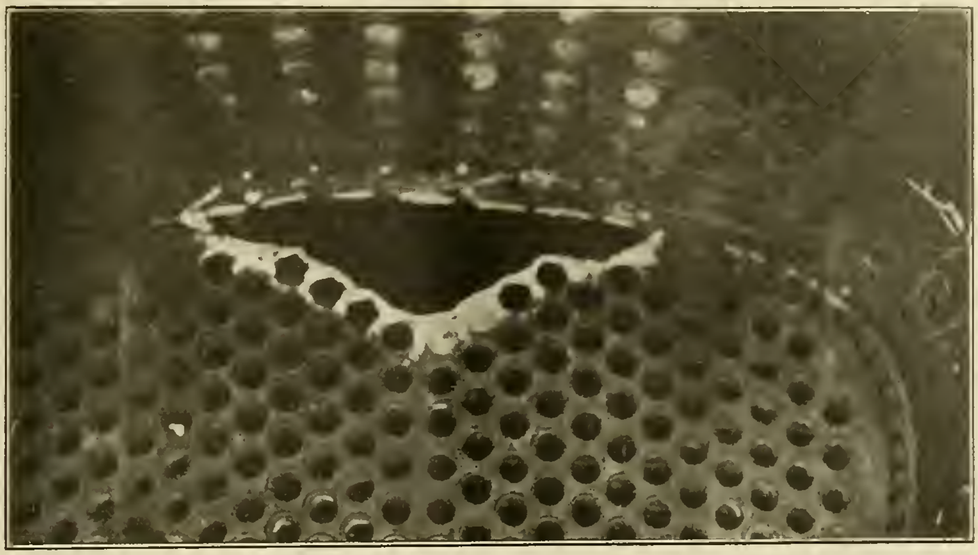
A space on the side sheet of this same firebox, about 16 in. in diameter, had a number of cracks at the stay bolts. These had been repaired by screw plugs and caulking, but were again giving trouble. The sheet was easily repaired with the oxy-acetylene welding process.

One of the illustrations shows two small test plates of ⅜ in boiler plate, which had been welded by the oxy-acetylene process. After cooling off they were bent at the weld and hammered flat under a steam hammer without fracturing the material. Another piece of the same size was welded and tested for tensile strength. No metal was piled on or added to the weld to reinforce it; the test showed 90 per cent. of the strength of the original piece.



WELDED BOILER PLATE SUBJECTED TO SEVERE TEST. HAMMERED FLAT UNDER A STEAM HAMMER AFTER COOLING OFF.

Five of the spokes of the flywheel, also illustrated, were successfully welded. Those who are familiar with the difficulty in



SHOWING THE EXTENT OF THE PART THAT WAS REPLACED ON THE TUBE SHEET.

THE FIREBOX TUBE SHEET AFTER WELDING ON THE PATCH.

making repairs of this kind, due to expansion, will appreciate this piece of work.

The repairing of automobile parts with the oxy-acetylene blowpipe has become so common that it is not unusual to jack up an auto side frame and weld it *while you wait*.

The portable apparatus by which these welds were made is shown in one of the illustrations and is manufactured by the Oxy-Carbi Company of New Haven, Conn. An important feature of the apparatus is the use of double purifiers for generating oxygen, thus insuring a high quality of gas. The double gauge arrangement makes it possible to determine at any time whether either retort has exhausted its oxygen, and eliminates unnecessary waste of gas by overheating the retorts. Special alloy needle valves retain the gas in the storage tank when not used. Where much oxygen is used for cutting the retorts may be used alternately with very satisfactory results.

The acetylene generator is entirely automatic in action. By a slight turn of the regulator the working pressure may be adjusted to the required amount. Generation is immediately stopped without any waste when the consumption of gas is cut off. No odor of gas is noticeable from the machine, even if operated in a small room. The large carbide capacity makes it especially desirable for long runs or heavy work.

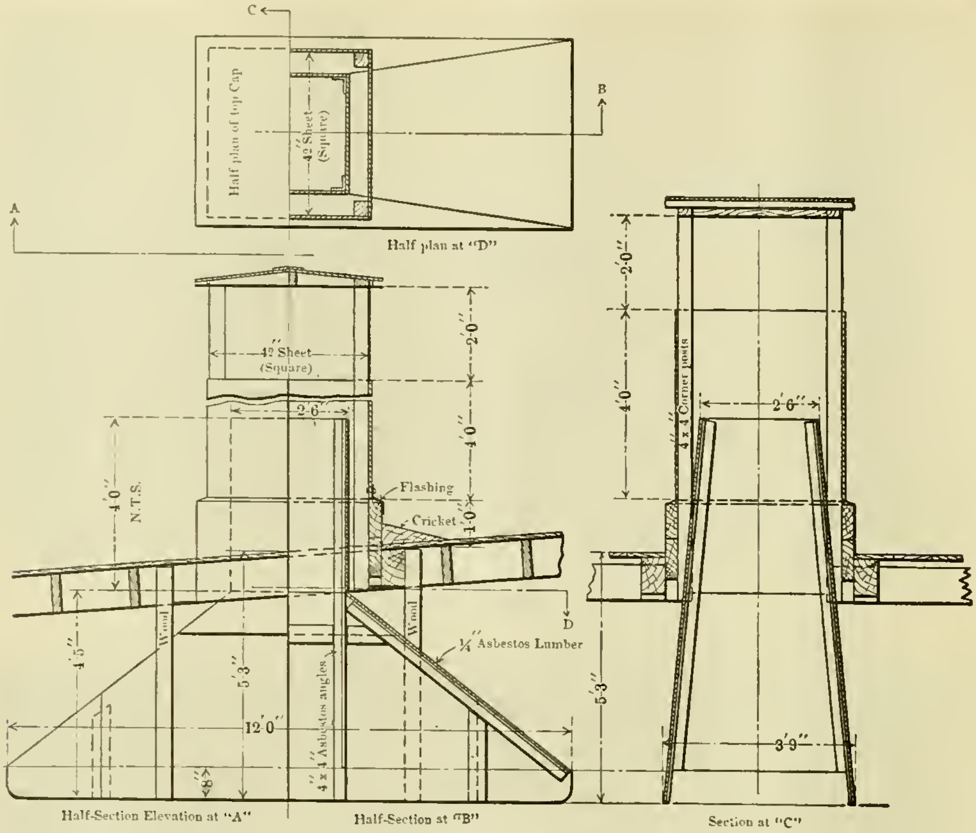
Railroads entering Atlanta, Ga., must publish a joint passenger train schedule in at least one of the daily papers.

OPERATION OF BRITISH PATENT ACT.

From a consular report it is noted that the first year's working of the British patents act has resulted in the introduction into the United Kingdom of $2,500,000 foreign capital. The value of the land and premises acquired by foreign firms who have decided to carry on their manufactures in Great Britain in order to maintain patent rights is estimated at $635,000. The expenditure for buildings was $880,000; plant and machinery, $895,000, making a total of $2,110,000. In addition, it is stated that a great many firms have arranged for English factories to manufacture their patented articles on a royalty basis.

The consul making the report is of the opinion that the results of the act have come up to expectations and believes its beneficial effect to England will continually increase.—*American Machinist.*

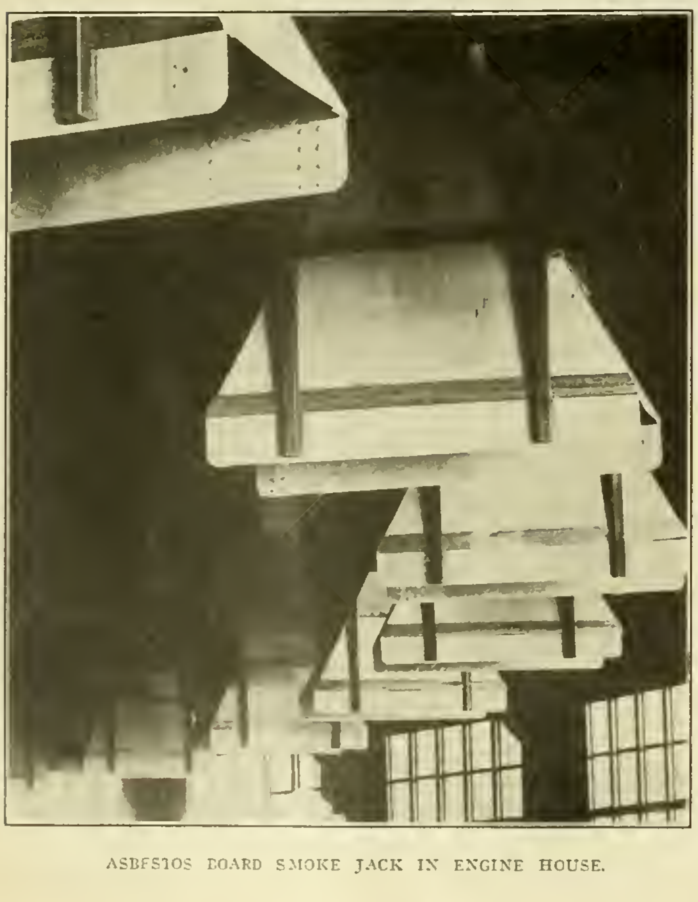
College for Apprentices at Altoona.—The trustees of the Pennsylvania State College have decided that the college, in connection with the Pennsylvania Railroad, shall establish a college for apprentices in the mechanical department of the Pennsylvania shops at Altoona. The school will begin with 30 students from the four-year apprentices at the shops. It will be started about the middle of February and be continued for three and one-half months. Instruction is to be given two afternoons each week.



APPLICATION OF ASBESTOS BOARD SMOKE JACK.

ASBESTOS BOARD SMOKE JACK.

On page 6 of the January issue in connection with the first part of the article on locomotive terminals was shown two interior views of the West Springfield engine house of the Boston & Albany Railroad, illustrating the arrangement and design of the smoke jacks. We are now able to illustrate the details of construction of these jacks and present a more satisfactory photograph.



ASBESTOS BOARD SMOKE JACK IN ENGINE HOUSE.

These jacks were designed on the basis of a most extensive and thorough study of the subject and illustrate probably the best present practice in this respect. The material selected was ¼ in. asbestos lumber furnished by the Franklin Mfg. Co., Franklin Pa., which presents many advantages for this construction. It is very light, is easily handled, is absolutely impervious to acids or gases, and is guaranteed for five years service and expected to have a life of over fifteen years. This lumber is made up of 85 per cent. Portland cement and 15 per cent. asbestos fibre, the corner angles being of the same material; the sheets are riveted with aluminium rivets. It is carried from the roof and braced on the outside by wooden timbers, which, of course, are not subject to deterioration.

It has seemed to be almost impossible to obtain a satisfactory material for smoke jacks, and if these jacks come up to expectations, as it is confidently expected that they will, one of the most troublesome problems of the mechanical and engineering departments will be solved.

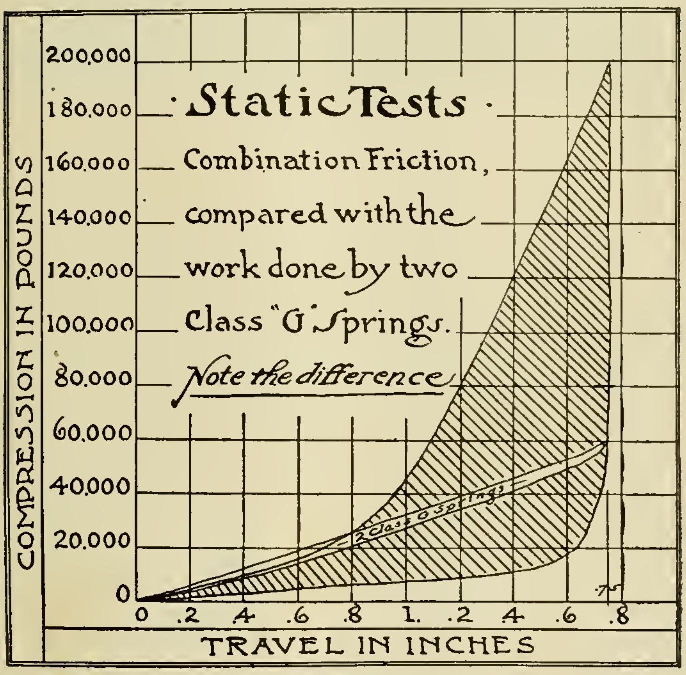
THE TUNGSTEN LAMP.—The tungsten lamp has practically revolutionized commercial lighting and is now being extensively adopted in industrial lighting, especially in textile mills. It is by far the most efficient of the incandescent class, and while the maintenance seems high in some cases, it is being rapidly reduced with the progress of development. Where lamps are protected from excessive vibration or shock, the tungsten is giving an exceedingly long burning life. In choosing between tungsten and tantalum, the cost of current and the size of unit desired are usually determining factors. Tungsten lamps are used singly or in groups with metal diffusers or prism glass reflectors. Where there is considerable building vibration, they are provided with spring suspensions.—*G. H. Stickney on the "Illumination for Industrial Plants" in Proceedings of the Am. Inst. of Electrical Engineers.*

FRICTION DRAFT GEAR.

The Butler Drawbar Attachment Company has adapted the friction elements of the friction draft gear, made by it under the Piper patents, to the Miner tandem class "G" spring gear for cars with 12⅞ in. sill spacing; this is done in such a manner that the spring gear can be raised from a 60,000-lb. to a 200,000 lb. capacity friction gear. The interesting tests of friction draft gears in actual service, made during the past year, have shown the great value of absorbing more of the shocks of buffs and jerks than is possible with the best of the spring gears. Col. W. B. Dunn, chief inspector of the Bureau for the Safe Transportation of Explosives and other Dangerous Articles, in speaking of recent tests of the shocks of loaded cars, says that "the results show in a striking manner the value of the friction draft gear in reducing impact pressures."

In applying the Butler friction elements to the Miner spring gear, no material need be thrown away, as that which is removed is still good for repairs. The friction element introduced is not an experiment, as it is now in use in thousands of cars, and the slight change in the "Miner" makes an improvement to the gears now in service, which is of great value and at the same time is comparatively inexpensive.

A static test of this combined gear gives a splendid card, the



action of the single "G" spring giving a fine preliminary movement, the friction elements gradually coming into action without a sudden jump or shock, a thing which tests in quick impact have shown often prevents the friction parts going into operation at all. This fact makes the early spring movement a valuable feature in the gear, as well as taking up the very large amount of slight shocks incident to shifting and starting movements.

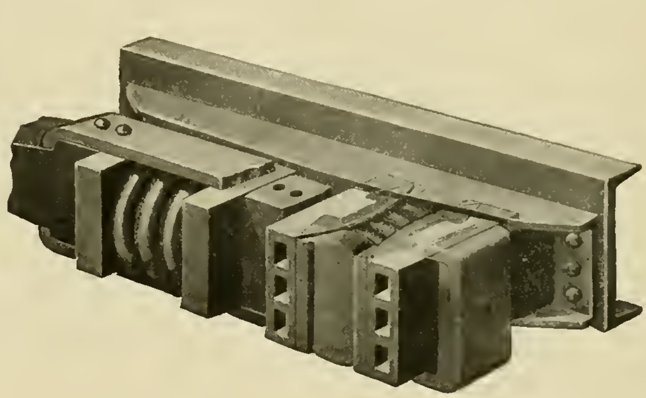
Entertainment for Santa Fe Employees.—With the completion of new buildings, every division headquarters of the Atchison, Topeka & Santa Fe Ry. between Chicago and Los Angeles is now equipped with a reading room for employees and an auditorium in which theatrical performances are given periodically, at the expense of the company. Thirty buildings are included in this entertainment system, where the men have the opportunity not only of receiving educational benefits, but of enjoying music and art. Four concert companies have been engaged to provide a series of entertainments in the various auditoriums and prominent lecturers will be engaged. The reading rooms thus far established are equipped with forty billiard tables and eighteen pianos, in addition to 40,000 volumes of reading matter.

GROWTH OF PENSION SYSTEMS.

With the beginning of the new year, 165,000 railroad employees have been added to the 500,000 in this country to whom pension plans already apply. This large increase is due to the action of the New York Central and Rock Island lines, which have announced the installation of pension departments.

The latest government report on the number of railroad employees puts the total for the country at 1,672,074. Of these approximately 665,000, or about 40 per cent., serve the roads which have pension systems. Companies that now bestow pensions on employees are the New York Central, the Rock Island the Pennsylvania, the Buffalo, Rochester and Pittsburgh, the Chicago and North Western, the Illinois Central, the Santa Fe, the Union Pacific, the Southern Pacific and its affiliated lines, the Lackawanna, the Baltimore and Ohio, the Atlantic Coast Line, the Reading, and Jersey Central.

Under the plan of the railroads, the service of a man who is to receive a pension must be continuous. There are, however, certain exceptions to this. When an employee is disabled, for instance, or receives a leave of absence, or is suspended for discipline, or is temporarily laid off on account of a reduction in force, this is not considered a break in the continuity of service. Only by voluntarily leaving the company or by being discharged for good cause does an employee disqualify himself for a pension. One of the most important results of the pension policy is that it encourages long service and thereby increases efficiency.—*Railway World*.



PERSPECTIVE VIEW OF BUTLER FRICTION DRAFT GEAR WITH MINER ATTACHMENTS.

A CENT'S WORTH OF ELECTRICITY.

At the average rate for power paid by the ordinary consumer, says *Harper's Weekly*, a cent's worth of electricity will operate a 12-inch fan for 90 minutes.

Will operate a sewing-machine motor three hours.

Will keep a six-pound electric flatiron hot 15 minutes.

Will make four cups of coffee in an electric coffee percolator.

Will keep an 8-inch disk stove hot seven minutes, or long enough to cook a steak.

Will operate a luminous radiator eight minutes.

Will bring to a boil two quarts of water or operate the baby milk warmer twice.

Will make a Welsh rarebit in an electric chafing dish.

Will operate a 7-inch frying pan 12 minutes.

Will keep a heating pad hot two hours.

Will operate a griddle eight minutes.

Will run the electric broiler six minutes.

Will run a massage machine nearly four hours.

Will keep the dentist's electric hammer and drill going 90 minutes.

Will keep the foot warmer hot a quarter of an hour.

Will run an electric pianola one hour.

Will vulcanize a patch on an automobile tire.

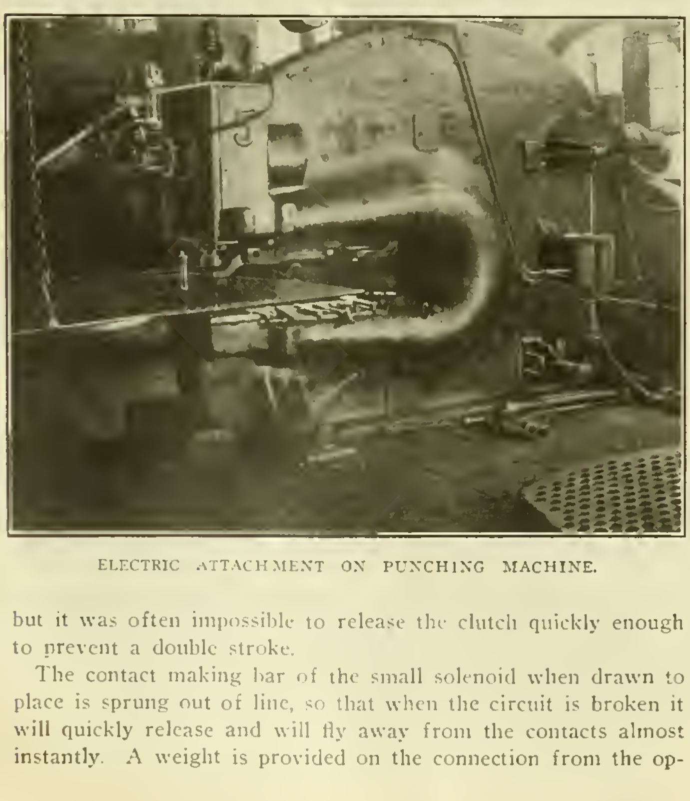
Will heat an electric curling iron once a day for two weeks.

AN ELECTRIC ATTCAHMENT FOR PUNCHES.

A device for use in connection with punches in the boiler shop, which not only saves the use of an extra man, but also permits much more accurate work on sheets of large size, is shown in the accompanying illustrations. This device was originally designed by the Pennsylvania Steel Company and used in its plant. With its permission the Pennsylvania Railroad is using it in their Altoona shops, where it has been applied to a No. 5 Hilles and Jones punching press. Three additional machines are now being equipped with it at the Juniata shops. The scheme used is to disconnect the foot connection to the clutch for throwing in the punch and operate it by means of a solenoid, the circuit to which is controlled by a push button in the top of the drift pin with which the boiler maker guides the sheet that is being punched. In this way a boiler maker and one helper are easily able to handle the largest flue sheets, since neither is required to move his body or make any change in position which might possibly affect the location of the sheet. After the sheet is located by the prick punch mark the pressure of the thumb on the button will throw the punch into operation, the sheet being held steady meanwhile.

The electric circuit required for an apparatus of this kind is shown in the diagram. It requires the use of two solenoids, one for the main operating device, having a pull of about 125 lbs. on a 120 volt circuit, and the other a contact making device, which is connected to the push button by a flexible cable and is on a 10 volt circuit.

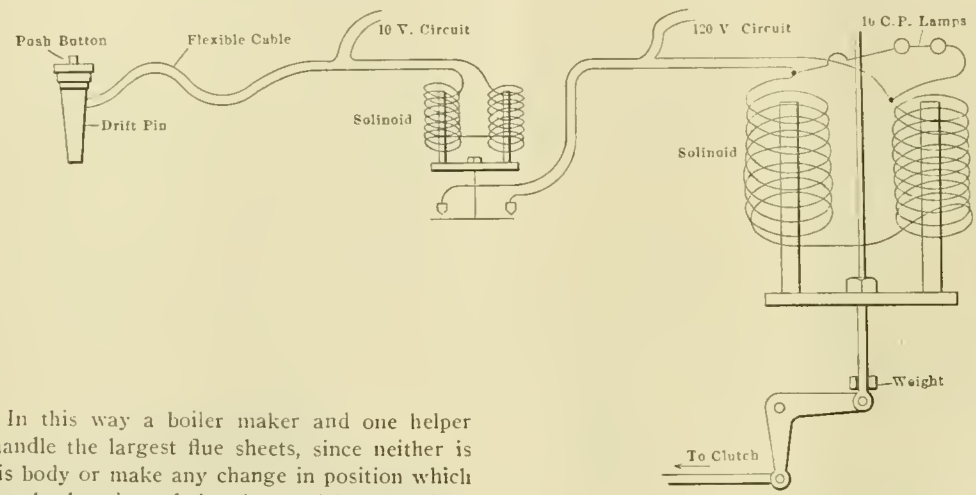
Experiments were first tried with the operating solenoid alone,



ELECTRIC ATTACHMENT ON PUNCHING MACHINE.

but it was often impossible to release the clutch quickly enough to prevent a double stroke.

The contact making bar of the small solenoid when drawn to place is sprung out of line, so that when the circuit is broken it will quickly release and will fly away from the contacts almost instantly. A weight is provided on the connection from the operating solenoid to assist in releasing the clutch. Two 16-candle power lamps are connected across the circuit, as is shown in the diagram, to take what is commonly known as the "kick-back" when the circuit is broken in the coils.



THE ELECTRIC CIRCUIT USED WITH THE SOLENOID ATTACHMENT.

CASE HARDENING.

In discussing this subject before the recent convention of the International Railroad Master Blacksmiths' Assn., H. Pentecost, of the American Locomotive Company, said:

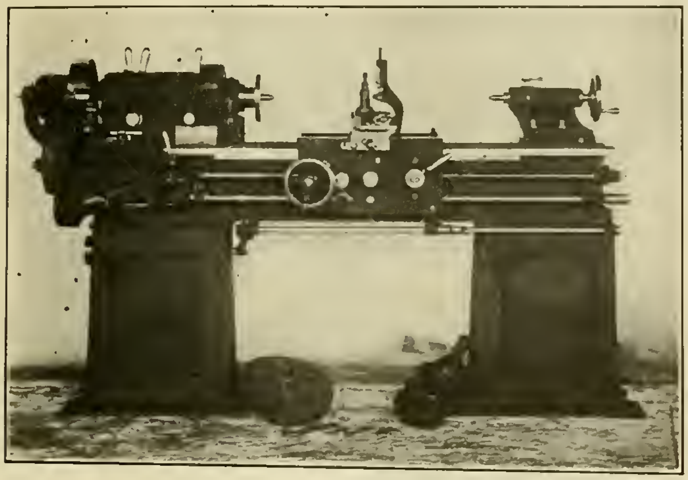
"We have quite an elaborate and up-to-date system of case hardening, having furnaces built especially for the work and men engaged for that purpose alone. We consider our case hardening about as good as can be done, as we have spared neither time nor expense to get good results. Our furnaces are built of special fire brick, each with two chambers or retorts made air tight, instead of boxes, as are generally used, with the fire space below between the two. These chambers are each 15 x 16 x 81 in.; large enough to take in anything on an engine that needs case hardening from a guide down to the smallest pin. These furnaces are full of flues that surround the chamber or retort where the case hardening is done, so as to keep it at an even heat all the time.

For fuel we use hard coke, as from our experience we get a more satisfactory heat than when using either coal or oil. For case hardening mixture we use charcoal, ground bone and potash, and mix them in the proportion of 200 lbs. charcoal with 50 lbs. each of ground bone and potash, renewing our mixture about every three or four days, according to the size and amount of work we are doing. At the present time we are case hardening guides 3 x 8 x 66 in., and can put in, using both chambers, two complete sets, besides other small pieces. We keep these guides in the furnace 20 hours, as we consider that none too long to make a good job. Steel guides, where we case-harden them, are left in the furnace from 8 to 10 hours. For iron links, 10 to 12 hours, and steel links 6 to 8 hours, according to the size. We have a jib crane with cable air hoist to lift the work out of the furnace, with tanks in the floor large and deep enough to take in all the furnace will hold. We keep these furnaces going all the time and have men taking care of them both day and night."

Forest Products in 1908.—The total value of the forest products of the United States in 1908 is estimated to have been $1,050,000,000, a decrease of nearly 18 per cent. from the value in 1907, due chiefly to the business depression.

HIGH SPEED LATHE.

The geared head high speed engine lathe shown in the illustrations, and manufactured by the Prentice Bros. Company, Worcester, Mass, is the standard lathe redesigned throughout in much heavier construction and equipped with a new spindle reversing mechanism in the headstock. The design secures a single belt machine which simplifies the installation of a motor drive, if it should be desired, and at the same time contains in the machine itself all the elements except the motor and the



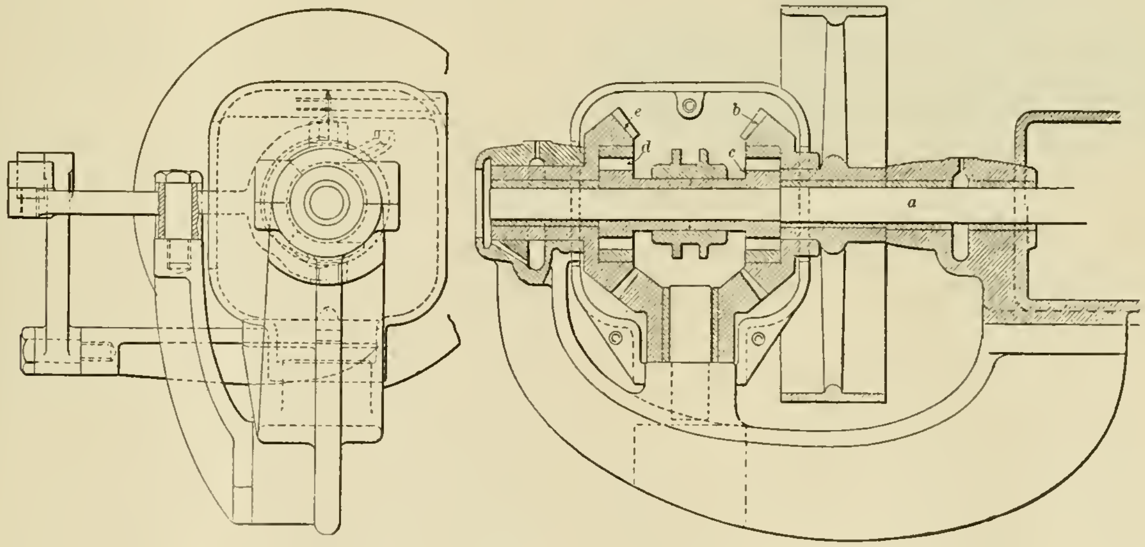
PRENTICE GEARED HEAD HIGH SPEED LATHE.

bracket upon which it is mounted. The greatest objection to lathes of the motor driven type—that of delay in securing them—is thus overcome.

To convert a standard belt driven machine to a motor driven one, it is only necessary to bolt a bracket on the rear side of the head end cabinet leg and belt from the motor direct to the driving pulley. Provision is made for adjusting the height of the bracket by a screw which acts as a belt tightener. Where the lathe is located underneath the line of shafting it is belted direct to the pulley on the headstock, without the intermediary of a countershaft. Eight changes of spindle speed are provided in the headstock.

The spindle reversing mechanism, details of which are shown in the drawing, is located on the driving shaft *a* and comprises three bevel gears and two friction clutches, together with the levers for operating them. The controlling lever is located on the apron, with which it travels, so that the operator always has it immediately at hand for starting, stopping and reversing the spindle, no matter how long the lathe bed may be. The bevel gear *b* is mounted on the hub of the driving pulley, and when it is engaged by the friction *c*, the pulley and bevel gear are tight with the shaft and the spindle drives direct. The bevel gears then run idle and carry no load. To reverse the spindle the friction *d* is thrown into engagement with the bevel gear *e*, which is clutched to the shaft, and the drive is through the three bevel gears.

The distance between centers for a 6-ft. bed on the 12-in. lathe is 33 in., the swing over the ways is 14½ in. and over the compound rest 9½ in. The machine will cut 44 pitches of screw threads ranging from 4 to 60 threads. The net weight with a 6-ft. bed is 2,065 lbs.



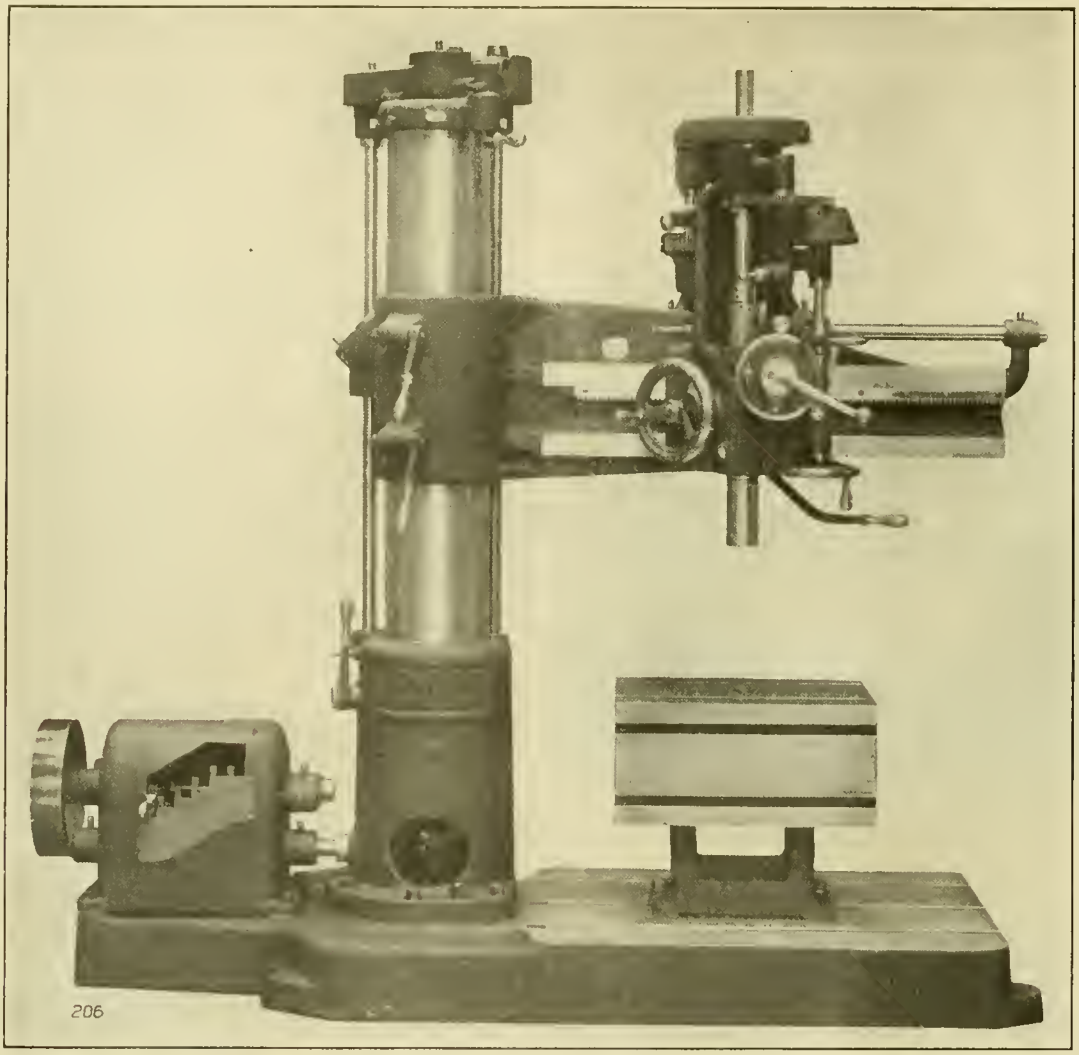
DETAILS OF SPINDLE REVERSING DEVICE ON HIGH SPEED LATHE.

A Trade Paper Consolidation.—Announcement is made of the consolidation of *Industrial Engineering*, heretofore published at Pittsburgh, and the *Engineering Digest*, New York. The offices will be at 220 Broadway, New York. Robert T. Kent, editor of *Industrial Engineering*, becomes managing editor of the consolidated magazine. Harwood Frost, who was the founder of the *Engineering Digest*, and one of its editors, will now devote himself entirely to the *Engineering News*.

Toys.—Few realize that more than $50,000,000 worth of toys have been imported into this country during the last decade. Despite this large importation the growth of the production of toys in the United States has been rapid in recent years, increasing from $1,500,000 in 1880 to $5,500,000 in 1905. The growth of toy making in this country has been chiefly in those which could be manufactured by machinery.—*American Machinist.*

Amount of Oil in Saturated Waste.—There is a limit to the amount of oil which can be absorbed by the waste in the journal box. Careful experiment has shown that one pound of waste will absorb and hold four pints of oil. Any amount in excess of this will not remain in the waste, but will run down through it into the bottom of the box.—*William J. Walsh before the New England Railroad Club.*

Dope for Pipe Threads.—In screwing pipe fittings together spread a thick mixture of graphite and oil on the threads. This will help make the joints steam or water tight. White lead is used when the pipe is not to be taken apart again. It hardens, while the graphite does not, and makes it almost impossible to unscrew the pipe fittings when they have been connected for a long time.—*Gas Review.*



CINCINNATI-BICKFORD IMPROVED RADIAL DRILL.

IMPROVED RADIAL DRILL.

The smallest sizes of the line of radial drills manufactured by the Cincinnati-Bickford Tool Company, Cincinnati, Ohio, have recently been redesigned. This includes the 2½, 3 and 3½ foot drills. The improvements which have been made add greatly to their efficiency. The design has a column extending to the top of the sleeve, ribbed internally to furnish a high degree of stiffness. It is mounted on a base which has been considerably strengthened at the point where the flange is bolted down. The ring that supports the elevating screw and takes the weight of the arm itself, is now supported on ball bearings, greatly reducing the force required to swing the arm. The pipe section of the arm has been retained, giving a high degree of strength and stiffness.

The power of the drive has been augmented by putting on a larger driving pulley, allowing a greater belt capacity. The gear box allows changes to be made while the machine is running at a high speed, by the simple changing of the lever from one notch to the other. This may be done without taking special precaution to prevent breakages. The settings for the different diameters of drills are given below the notches in which the change gear lever rests. Gears subjected to hard service are of hardened steel. The bevel gears transmitting the power to the column have been increased in size.

The back gears are located in the head. They are of simple construction, consisting of three gears and a clutch, and may be engaged or disengaged while running. The clutch is made of high grade carbon steel and has hardened teeth. The gear-box and back-gears provide twelve changes of speed, ranging from 38 to 356 revolutions per minute; they are correct for a cutting speed of 35 feet per minute for drills from ⅜ inch to 3½ inches in diameter.

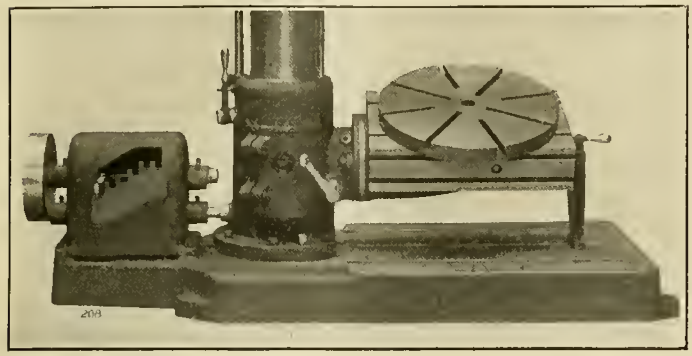
The reversing clutch, the lever for which may be seen extending below the head, is expanded by a plunger and toggle-joint arrangement, whereby its capacity is increased many times over that of the wedge type of clutch formerly used. Adjusting screws permit the friction rings to be set to any tension desired. The reversing lever is employed for starting and stopping the machine as well, being within convenient reach of the operator.

The feed change device operates by means of a ball handle controlling a driving key mechanism. This gives four changes ranging from 0.008 to 0.020 inch advance per revolution of the spindle. Any one of these feeds is instantly available. The feed clutch is made of hardened steel. The thrust of the feed worm is taken on a ball bearing instead of on a fiber washer. The spindle sleeve also exerts its pressure on the spindle through a ball thrust bearing, reducing the power to run the machine nearly 22 per cent. This, with the increased diameter of the driving pulley, makes the machine capable of doing much heavier work than formerly.

The quick return handle on the feed pinion shaft is provided with a toggle-joint type of adjustable clutch. This requires but a slight force to engage it, thereby avoiding the possibility of throwing the handle out of position by a sudden violent effort. Instead of graduating the spindle sleeve as formerly, depths are now read from a dial permanently located on the quick return head on the feed pinion shaft. The automatic stop is also made a part of the depth gauge, and it may be set in position instantly without requiring trial cuts or measurements.

The guide on the top of the arm for the adjustment of the head is made flat instead of angular, thereby allowing the head to move more easily, and minimizing the tendency for it to rock on the arm while the machine is in operation. The head clamping device has the important feature of tightening the gib in the head instead of lifting it away from it. This gib is now made taper instead of flat and is fitted with an improved adjusting device which eliminates the undesirable feature of having the weight of the head rest on the point of two screws. It also prevents the possibility of any end play.

Three forms of table are provided. In the general view of the machine the box table is shown clamped on the base of



UNIVERSAL SWINGING, TILTING AND ROTATING WORK TABLE.

the machine, and provided with working surfaces on both sides as well as on the top. One of the illustrations shows a swiveling table provided with a wormwheel adjustment for setting it to any angle about a horizontal axis, the angle being indicated by a graduated ring of large diameter; a dowel is provided for locating it in the horizontal position. This design is also furnished, if desired, as a plain swinging table, without the swiveling attachment. The round work-table shown is a supplementary device which may be placed on the box, swinging or swiveling tables.

Special attention is directed to the very complete set of gear guards provided. This is in line with the modern tendency of safeguarding the workman. It has other advantages as well, however. It protects the gears from accidents, such as are particularly likely to occur in shops having traveling cranes. It prevents the throwing of oil over the clothes of the operator; it also adds greatly to the appearance of the machine.

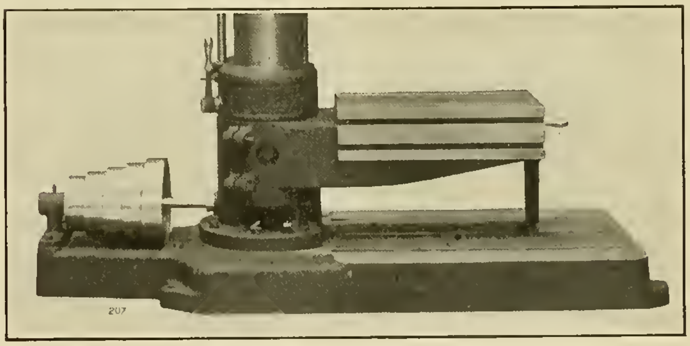
THE IDEAL LOCOMOTIVE.

The "ideal locomotive" has received considerable discussion in the columns of *The Engineer* (London) during the past year. The result is summed up in a recent editorial in that publication, from which the following extract has been taken:

"The locomotive is the most remarkable machine ever constructed to develop power. No other motor works under the same varying conditions. At one moment we find it developing maximum horse-power while making, perhaps, ninety or one hundred revolutions per minute. Soon afterwards it is again giving out maximum power, while its cranks are turning round 300 or 350 times in a minute. It is a slow-speed engine. It is a high-speed engine. It is an all and every speed engine; and it is expected to be economical, no matter what the average cylinder pressures may be. The resistance which it has to overcome varies from minute to minute. It must behave well as a vehicle. It must be beyond all other machines trustworthy. With heavy, fast, long-run trains it has to work within an inch of its life for hours together. There is nothing like it in the world. The motor car has no such difficulties to contend against. If it has to climb a hill the gear is changed. There is no change gear for the railway engine. The torpedo destroyer's engines are to a certain extent like the locomotive; but the occasions when full power is wanted and put forth are quite rare. With the locomotive maximum power is the rule, not the exception.

"It ought to be obvious that to get an ideal engine under such conditions is from one point of view hopeless; from another we have it already. Every locomotive is an ideal machine. All depends on the concept formed, on the standard of excellence to which the ideal engine must conform. As we have already said, each man will shape his own ideal, or will reject the notion as impracticable. So far no one has attempted to do more than say that some given type will be better than other types; but the so-called proof is seldom convincing, or, if convincing, satisfying. Take, for example, compounding. It would be quite out of place to say anything here about the merits or demerits of the system from a theoretical point of view. It is certain, however, that the principle has been very fully and carefully tried for a great many years on many of our great railways under the most varying conditions, and on none of them has it retained its position. It is merely wild hitting in the dark to say that its unpopularity is due to prejudice. The truth is that the only possible advantage the compound has over the non-compound is fuel economy; but as we have often explained, the saving must be a very large one if it is great enough to counteract contingent disadvantages. So far as we are aware, no one attempts to say that under favorable conditions the compound will not save coal. But the facts go to show either that these conditions are not present on British railways to any notable extent; or else that the expenses of maintenance and so forth are so great that compounding is not worth having. It is improbable that any of our correspondents has had recent running shed experience, or has received drivers' and examiners' weekly and daily reports. These things do not reach the public, but they represent very special and valuable information, enabling locomotive superintendents to decide on the perpetuation or rejection of any particular system of construction or method of working.

"We do not, of course, wish it to be supposed that we think that finality has been reached, and that no further developments or improvements are possible. Far from that, we believe that they will be made; but it is not necessary that they shall be



PLAIN SWINGING TABLE ON RADIAL DRILL.

confined to augmenting economy in fuel. But even in that progress will take place. Superheating has for some time past been tried on a scale and with a completeness never before attempted in this country. Of the economy secured there is no question. Nothing but the lapse of time can tell us whether the price paid for the saving is or is not too great."

The Tungsten Lamp.—All previous developments of incandescent lamps have told of progress, but the introduction of the tungsten lamp means a *revolution* in lighting work. Reaching, as it does, a standard three times higher than the present incandescent lamps, the tungsten lamp surpasses all other forms of lamps in efficiency—the arc and the Nernst are all outclassed, with the possible exception of the flaming arc and some forms of vapor tube lighting. By means of its numerous and well-known advantages the incandescent lamp has maintained itself in the field in competition with other illuminants, and now that it is able to match them in efficiency, there will probably be no limit to its use except the ability of the public service corporations to supply service therefor.—*F. W. Willcox before The Engineers' Club of Philadelphia.*

FIRST SOLID STEEL PASSENGER TRAIN, COMPOSED OF DAY COACHES, DINING CAR, AND PULLMANS, OPERATED BY THE PENNSYLVANIA RAILROAD COMPANY, AND THE FIRST SUCH TRAIN EVER OPERATED ANYWHERE.

STEEL PASSENGER CARS ON THE PENNSYLVANIA.

The Pennsylvania Railroad in November, 1906, ordered 100 all-steel passenger cars. Since that time additional orders have been placed and there are now in service on the company's lines 245 coaches, 10 dining cars, 21 combination passenger and baggage cars, 29 baggage cars, 18 postal cars, and one company car; a total of 324 cars. In course of construction there are 140 coaches, 34 dining cars, 48 combination passenger and baggage cars, 4 baggage cars, 42 postal cars, 27 mail storage cars, and 11 baggage and mail cars.

The Pullman Company, at the instance of the Pennsylvania Railroad, has for the past four years been at work designing all-steel parlor and sleeping cars. Some 500 such cars are shortly to be completed and placed in service on the Pennsylvania Railroad.

With the all-steel passenger equipment now in service, or on order, and some 250 steel cars to be ordered on the 1910 passenger equipment programme, the Pennsylvania Railroad will, in a short time, have in service about 900 of its own steel passenger cars, and 500 steel Pullman cars.

BOOKS.

"Fuel Tests with House Heating Boilers," by J. M. Snodgrass, is issued by the Engineering Experiment Station of the University of Illinois as Bulletin No. 31. This bulletin is designed for the technical rather than for the general reader. It will be of interest to producers of fuel for domestic heating and to those who are concerned with the design and method of house-heating apparatus. Comparatively few tests have hitherto been made in connection with house-heating apparatus, and the results of this bulletin constitute a timely definition of its efficiency. The bulletin is intended to constitute the first of a series dealing with fuels and apparatus used for house-heating or other domestic purposes. Copies may be obtained gratis upon application to W. F. M. Gross, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

"Tests of Tungsten Lamps," by T. H. Amrine and A. Guell, issued as Bulletin No. 33 of the Engineering Experiment Station of the University of Illinois, presents the results of tests upon tungsten lamps of the 25-watt size. Of the three kinds of lamps tested, one kind was of American manufacture with filaments made by the paste process; the other two kinds were of German manufacture, with filaments made by the colloid and deposition processes. Each type of lamp had a different scheme of filament mounting.

From these tests it is shown that:

(1) When the lamps are subject to vibration, the life depends to a great extent upon the scheme of filament mounting, so that a lamp having its filaments mounted in such a manner that they are never under tension, gives a much better life, when subject to vibration, than one having tightly strung filaments.

(2) After burning 2,000 hours under good conditions of operation, the average candle-power of the filaments made by the paste process, decreased to 88 per cent.; of the filaments made by the deposition process to 89 per cent.; and of those made by the colloid process to 77 per cent. of the initial value.

(3) The paste filament lamp, with loosely strung filaments, gives the longest life under both good and poor conditions of operation.

(4) The frequent breakage of the filaments during shipment and ordinary handling, and the early blackening of the bulbs, common in the early tungsten lamps, seem to have been overcome in all three types of lamps tested.

Copies of this bulletin may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Proceedings of the Traveling Engineers' Association. Seventeenth Annual Convention held at Denver, Colorado, Sept., 1909. Leather, 374 pages, 6 by 9 in. Secretary W. O. Thompson, 820 Elmwood ave., Buffalo, N. Y.

The proceedings of this association should be studied by those who are in charge of the compiling and arranging of the proceedings of railway clubs and associations. Well printed, neatly and carefully arranged and with first-class half-tones and line drawings, it forms quite a contrast to the average book of this kind. Among the principal reports and papers presented and discussed were the following: The most economical method of maintaining engine equipments; fuel economy (report and discussion cover over 60 pages); proper method of handling air brakes on long trains to insure smooth service (60 pages); boiler check valves and feed water delivery—does their location and arrangement affect the working of the injector, steaming of the boiler and formation of scale; piping arrangement between engine and tender for steam, air and water; modern methods of cleaning ash pans; function of the parts of Walschaert valve gear, method of procedure in failure or breakdowns on simple and compound engines, including Mallet type; electric locomotives; what can be done to obviate tender derailments.

"The Occluded Gases in Coal," by S. W. Parr and Perry Barker, issued as Bulletin 32 of the Engineering Experiment Station, University of Illinois, contains the results of researches to determine the behavior of coal upon exposure to the atmosphere with reference to the gases normally contained by it in the mine. The investigation is a part of a study which is being made by the Engineering Experiment Station relating to the deterioration and weathering of coal as well as its spontaneous combustion.

As a result of these experiments, it appears (1) that freshly mined coal when subjected to a vacuum yields an appreciable percentage of combustible hydrocarbons; (2) that the escape of these combustible hydrocarbons takes place slowly in coal exposed to ordinary atmospheric conditions, and is almost entirely suppressed when submerged in water; (3) that the avidity of coal for oxygen is so marked that a sample in an air-tight jar with a large volume of air quickly exhausts the air completely of its oxygen; and this experiment may be repeated a number of times without appreciably lessening the avidity of the coal for oxygen; (4) a comparatively small amount of this oxygen shows itself as carbon dioxide of water, but is seemingly more largely involved in the formation of organic acids, such as humic acid, etc.; (5) the finely divided coal is more active in these processes than the coarse coal. On the whole, these experiments, as above summarized, afford positive indications as to some of the underlying causes of the heating and spontaneous combustion of coal in storage. Copies of this bulletin may be obtained upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Railways of China.—China possesses 6,300 miles of railways, of which only 1,930 are managed by the Chinese. The management of the remaining 4,370 miles is divided among six foreign powers, as follows: Russians manage 1,077 miles, Belgians 903 miles, Japanese 702 miles, Germans 684 miles, English 608 miles, and Frenchmen 400 miles. When the railways now being laid down in China are finished, the total length of China's railway system will amount to 8,000 miles.—*The Engineer* (*London*).

RAILWAY CLUBS.

Canadian Railway Club (Montreal).—At the meeting on Tuesday, March 1, G. I. Evans, chief draftsman of the motive power department of the Canadian Pacific Railway, at Montreal, will present a paper entitled "An Experimental Mallet Articulated Locomotive." Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal, Can.

Central Railway Club (Buffalo).—At the meeting on Friday, March 11th, J. R. Sloan, general electrician of the Pennsylvania Railroad at Altoona, will read a paper on "Electric Car Lighting." Secretary, H. D. Vought, 95 Liberty street, New York City.

New England Railroad Club (Boston).—On Tuesday evening, March 8th, there will be a discussion on the "M. C. B. Rules of Interchange." This is also the annual meeting of the club. It will be held at the Copley Square Hotel; dinner will be served at 6:30 P. M. Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

New York Railroad Club.—Friday evening, March 18th, will be the "Annual Electric Night," at which time the report on "Electrification" will be presented by a standing committee appointed some time ago. Secretary, H. D. Vought, 95 Liberty street, New York City.

Railway Club of Pittsburgh.—The standing committee on the M. C. B. rules of interchange will make its report at the next meeting, Friday, March 25th. Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

Western Railway Club (Chicago).—At the March meeting, Tuesday, the fifteenth, the committee on "Revision of the Rules of Interchange" will present a report. Prof. H. Wade Hibbard of the University of Missouri will also read a paper, the subject of which has not yet been announced. Secretary, Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

Other Club Meetings.—Iowa (Des Moines), Friday, March 11. Northern (Duluth), Saturday, March 26. Richmond, Monday, March 14. St. Louis, Friday, March 11. Western Canada (Winnipeg, Man.), Monday, March 14.

Elimination of Grade Crossings.—While invariably avoiding grade crossings on new and revised construction work, the Pennsylvania Railroad has, in the last ten years, been eliminating all crossings at grade as rapidly as practicable. A compilation for the period since January 1, 1900, shows that 673 grade crossings have been removed on the lines of the system east of Pittsburgh and Erie. These figures are of record of September 1, 1909, and do not include the ten crossings to be eliminated by the change of line to be made through Bristol, Pa., on the New York Division. On the lines of heaviest traffic between New York and Washington and Philadelphia and Pittsburgh, the company has abolished 256 public grade crossings in the past ten years. The 774 public crossings remaining are scattered over 574 miles of road, and are, with a few exceptions, at unfrequented highways where traffic is inconsiderable. There have also been removed, in addition to the 256 public crossings, 129 private crossings at grade.

PERSONALS.

C. H. Kenzel has been appointed assistant purchasing agent of the Elgin, Joliet & Eastern, with office at Chicago.

J. C. Miller, district master mechanic of the Chicago, Milwaukee & St. Paul, with office at Milwaukee, Wis., has retired.

E. C. Anderson has been appointed mechanical engineer of the Colorado & Southern Ry., with headquarters at Denver, Colo.

C. H. Montague has been appointed superintendent of motive power of the St. Paul & Des Moines, with office at Des Moines, Iowa.

D. H. Speakman, master mechanic on the Rock Island Lines, has been transferred to the Nebraska and Colorado divisions at Goodland, Kan.

W. J. Bohan, electrical engineer of the Northern Pacific at St. Paul, Minn., has been appointed mechanical engineer, with office at St. Paul.

Henry Mel, material agent of the National Railways of Mexico at Beaumont, Tex., has been appointed assistant purchasing agent, with office at Beaumont.

Richard Lanham, road foreman of engines of the St. Louis, Iron Mountain & Southern, at De Soto, Mo., has been appointed a master mechanic, with office at Paragould, Ark.

G. G. Gilpin has been appointed chief draftsman of the Chicago, Burlington & Quincy, to succeed E. C. Anderson, who has been appointed mechanical engineer of the Colorado & Southern Ry.

W. R. Thomas, road foreman of engines of the Cincinnati, New Orleans & Texas Pacific, has been promoted to general foreman of the mechanical and car departments, with office at Ludlow, Ky.

R. L. Stewart, master mechanic of the Kansas City terminal and the St. Louis division of the Rock Island Lines at Armourdale, Kan., has been transferred to the Missouri division, with office at Trenton, Mo.

H. J. Osborne, master mechanic of the Nebraska and Colorado divisions of the Rock Island Lines at Goodland, Kan., has been transferred to the Iowa and Des Moines Valley divisions at Valley Junction, Iowa.

W. Alexander, assistant district master mechanic of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., has been appointed district master mechanic, with office at Milwaukee, succeeding J. C. Miller, resigned.

J. F. Sheahan, master mechanic of the Southern Railway, at Knoxville, Tenn., has been appointed master mechanic of the International & Great Northern, with office at Palestine, Tex., succeeding F. S. Anthony, promoted.

James T. Wallis, superintendent of motive power on the Erie division of the Pennsylvania Railroad and of the Northern Central, has been appointed acting superintendent of the West Jersey & Seashore, also of the Philadelphia & Camden Ferry, with office at Camden, N. J., succeeding D. H. Lovell, granted leave of absence.

M. H. Wickhorst, engineer of tests of the Chicago, Burlington & Quincy, with office at Aurora, Ill., has been granted a leave of absence for one year to become chief chemist in charge of rail tests by the American Railway Engineering and Maintenance of Way Association. W. A. Derby succeeds Mr. Wickhorst.

W. Hamilton has been appointed master mechanic of the Western division of the Grand Trunk Railway System, with headquarters at Battle Creek, Mich., in place of E. D. Jameson, who has been assigned to other duties.

L. A. Richardson, master mechanic of the Missouri division of the Rock Island Lines at Trenton, Mo., has been appointed master mechanic of the Chicago terminal and the Illinois division, with office at Chicago, succeeding D. H. Speakman, transferred.

N. N. Boyden, master mechanic of the Southern Railway at Atlanta, Ga., has been transferred to Knoxville, Tenn. George Akans, master mechanic at Birmingham, Ala., succeeds Mr. Boyden; E. M. Sweetman, master mechanic at Sheffield, Ala., succeeds Mr. Akans, and Frank Johnson, general foreman of locomotive repairs at Knoxville, succeeds Mr. Sweetman.

Hugh M. Wilson, vice-president of the Barney & Smith Car Company, and well known to our readers as the publisher of the *Railway Age*, has been elected vice-president of the McGraw Publishing Company. Mr. Wilson succeeds Jas. M. Wakeman, who has been an important factor in the success of the McGraw Publishing Company with which he has been connected since its formation.

J. H. Guess, purchasing and fuel agent of the National Railways of Mexico at City of Mexico, Mex., has been appointed general purchasing agent of the Mexican International and the Interoceanic, with office at City of Mexico, and his former title has been abolished. A. Herrera has been appointed purchasing agent, with office at City of Mexico, succeeding Carl H. Smith, resigned.

J. E. Buker, having resigned as superintendent of car department of the Illinois Central, the Indianapolis Southern and the Yazoo & Mississippi Valley, to become first vice-president of the Chicago Car Heating Co., his former position has been abolished, and the duties of this position have been assumed by the superintendent of machinery. The position of J. M. Borrowdale, assistant superintendent car department, has also been abolished and Mr. Borrowdale will report to the superintendent of machinery and perform such duties as may be assigned to him.

H. A. Fabian, assistant to the president of the New York, New Haven & Hartford and the Central of New England at New Haven, Conn., has been appointed to the new position of manager of purchases and supplies of the New York, New Haven & Hartford and the Boston & Maine, with office at Boston, Mass., effective March 1. He also holds the same position on the controlled lines of the New York, New Haven & Hartford, namely, Central New England, New England Navigation Co. and the street railways, the Connecticut Co., New York & Stamford Ry. Co., Rhode Island Co. and the Housatonic Power Co., as well as for the controlled lines of the Boston & Maine, namely, Maine Central, Washington County and the Somerset Railway Co.

William Buchanan, superintendent of motive power of the New York Central & Hudson River Railroad for eighteen years up to 1899, died January 20, at his home in South Norwalk, Conn. Mr. Buchanan was born in Scotland, March 6, 1830. He came to this country when a boy and began railway work in the summer of 1847. In 1849 he was an apprentice in the shops of the Albany & Schenectady, but soon went to the Hudson River road, where he remained the rest of his active life. For three years he was machinist and shop foreman. In 1853 he became master mechanic, and in April, 1880, was made superintendent of motive power of the Hudson River and Harlem divisions. From April, 1881, to his resignation in May, 1899, he was superintendent of motive power and rolling stock of the entire system—the New York Central & Hudson River, the West Shore, the Rome, Watertown & Ogdensburg and the Dunkirk, Allegheny Valley & Pittsburgh.

CATALOGS.

LEACH SANDERS.—The various styles of this well known device are described in a catalog issued by the American Locomotive Sander Company, Thirteenth and Hamilton streets, Philadelphia, Pa.

STEEL TRUCK SIDE FRAME.—The advantages of the Buhoup steel truck side frame, manufactured by the McConway & Torley Company, Pittsburgh, Pa., are briefly stated in a neatly arranged pamphlet recently issued by them.

VANADIUM METALS IN RAILROAD SERVICE.—In a pamphlet under this title, published by the Vanadium Metals Company, Frick Building, Pittsburgh, Pa., the properties, the uses and the advantages of "Victor Vanadium Bronze" are discussed.

VERTICAL BORING MILLS.—The friction headstock and lever control of the Gisholt vertical boring mills, manufactured by the Gisholt Machine Company, Madison, Wis., is described in detail on a sheet intended for insertion in the loose-leaf binder furnished by that company.

THE JANNEY X COUPLER.—This improved coupler complies with all the requirements and also the recommendations of the Master Car Builders' Association, and meets every requirement of the safety appliance law. It is manufactured by the McConway & Torley Company of Pittsburgh, Pa., and is described in a pamphlet issued by that company.

TURRET MACHINERY—A 300-page, 4½ by 7¼ in., catalog on this subject has been received from Bardons & Oliver, Cleveland, Ohio. It consists of seven sections as follows: Part I, Turret lathes mounted on column with oil pan and oil pump; Part II, Turret lathes mounted on legs for working metals not requiring the use of a lubricant; Part III, Parts and attachments; Part IV, Tools; Part V, Illustrations and names of parts for use in ordering repairs; Part VI, Reference tables and data; Part VII, Index, etc.

THE DRAFT GEAR UP-TO-DATE.—The Union Draft Gear Company of Chicago, Ill., has published a booklet under this title, edited and arranged by Norman F. Rehm. It considers the development of the draft gear and discusses the limitations of the spring gears and the advantages and the necessity of using friction draft gears. The proper principles upon which the successful friction gear should be designed are stated. The booklet closes with an illustrated description of how to assemble the Cardwell friction draft gear.

TRAIN RESISTANCE.—The American Locomotive Company has recently issued Bulletin No. 1001, entitled "Train Resistance," which is a condensed and yet very complete discussion of this subject. The figures and formulæ given in the bulletin are based on a careful and analytical study of the most recent and exhaustive dynamometer tests and data obtained from the best authorities, and are probably more nearly correct for average American railroad conditions than any other like figures at present in use. The data is arranged in the form of tables and charts for convenient use, and the bulletin is one which will be of great practical value to railway officials.

NOTES

BURTON W. MUDGE & COMPANY.—This company of Chicago announces that Otto P. Hennig has been appointed sales manager in charge of sales, advertising and purchasing.

THE TITAN STEEL CASTING COMPANY, Newark, N. J., has purchased the business of Benjamin Atha & Company and will continue to operate the plant as in the past, giving special attention to the production of cast steel bolsters, manganese steel railway motor gears and pinions and other car and locomotive castings. The following are the officers of the new company: Benjamin Atha, president; Louis A. Shepard, vice-president and general manager; Henry G. Atha, treasurer, and C. W. Owston, Jr., secretary.

SIMPLEX RAILWAY APPLIANCE COMPANY.—In the suit of the Simplex Railway Appliance Company against the Pressed Steel Car Company for infringement of Simplex bolster patents, Judge Hazel, of the United States Circuit Court for the Southern District of New York, has just decided in favor of the Simplex Company, and has ordered an injunction against the Pressed Steel Car Company to restrain it from further use of the device, and has also ordered an accounting, with costs, in favor of the Simplex Company.

DEARBORN DRUG & CHEMICAL WORKS.—On May first this company will move their general offices and chemical laboratories from the Postal Telegraph Building, where they have been located since the organization of the company more than twenty years ago, to the new McCormick Building, on Michigan avenue and Van Buren street. The extensive growth of the business of the company has made necessary this removal to its new home, where the general offices and laboratories will occupy the greater portion of the top floor of one of the finest office buildings in Chicago. The Dearborn Company will have the entire frontage on Michigan avenue with a total floor space of more than 5,000 square feet.

READVILLE LOCOMOTIVE SHOP—NEW YORK, NEW HAVEN AND HARTFORD RAILROAD

A GENERAL DESCRIPTION OF THE ARRANGEMENT AND CONSTRUCTION OF THE BUILDINGS, GROUPING AND LOCATION OF THE MACHINE TOOLS AND METHODS OF OPERATION AT ONE OF THE MOST EFFICIENT RAILROAD SHOPS IN THE COUNTRY.

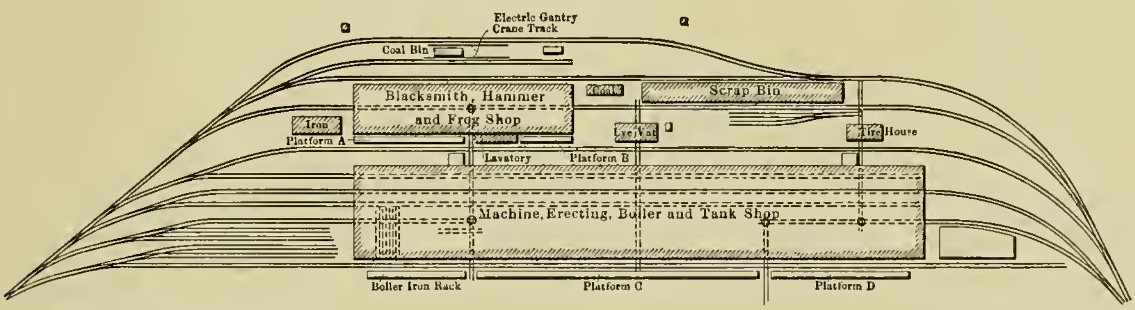
For the purpose of taking care of the heavy repairs on its steam locomotives the New York, New Haven & Hartford Railroad about three years ago put into operation a new and complete locomotive shop at Readville, a suburb of Boston, Mass. This shop is located adjacent to the large and thoroughly equipped passenger and freight car shops* that were constructed a few years previous and although the embankment of the Midland Division separates the two departments, it in no way interfering with the operation of the whole shop as a unit, under the direction of the shop superintendent. Undercrossings through the embankment at convenient points provide ample means of communication between the two shops.

One of the illustrations shows the general arrangement of the locomotive shop plant, which it will be seen consists of but two structures of large size. One very large building, measuring 150 x 904 ft. 6 in. outside dimensions, is used for the machine, erecting, boiler and tank shops. The other structure, 80 x 354 ft. 6 in. outside dimensions, houses the blacksmith, hammer and frog and switch shops.

The larger structure is parallel and adjacent to the embankment of the Midland Division, and the smaller is located just beyond and parallel with this building. There are also a number of smaller structures included in the arrangement, one being a storage for bar iron stock, located just outside of the blacksmith shop; another for coal, located at the opposite end of the blacksmith shop; the cleaning house enclosing the lye vats, opposite the center of the erecting shop; a tire house near one end of the erecting shop and the enclosed scrap bins located at a convenient point for access from both shops as well as the yard.

It will be noticed in the general layout that there are a row of platforms just outside of the machine shop building. These are of concrete about 3 ft. above grade and on them are stored boiler iron, flanging frames, tubes, castings and other rough stock for use in these shops. Their height is such as to bring them level with the deck of a push car and heavy parts are loaded by rolling or skidding. They extend the full length of the building, being divided into three parts by two passageways. Two similar platforms for storage of the material used in the blacksmith shop are located just outside of that building. The material on these platforms is storehouse stock and is under the supervision of a storehouse employee, who issues it only upon requisition from a foreman having the authority to sign requisitions. The stock is arranged, as far as possible, so as to be opposite the section of the machine shop that is to use it, making the transporting of rough castings and other material as convenient as possible. The same features apply also to the iron stock structure, where all bar iron is maintained as storehouse stock. The arrangement of this building will be described later.

Stock for use in the locomotive department, with the exception of tires, wheel centers, cylinders and other heavy parts that require a crane, is unloaded direct from cars on the track alongside the platforms and does not go to the general storehouse. The heavy castings and forgings are stored under the craneway near the tirehouse.



GENERAL ARRANGEMENT OF THE BUILDING AND TRACKS OF THE LOCOMOTIVE SHOPS AT READVILLE, MASS.—NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

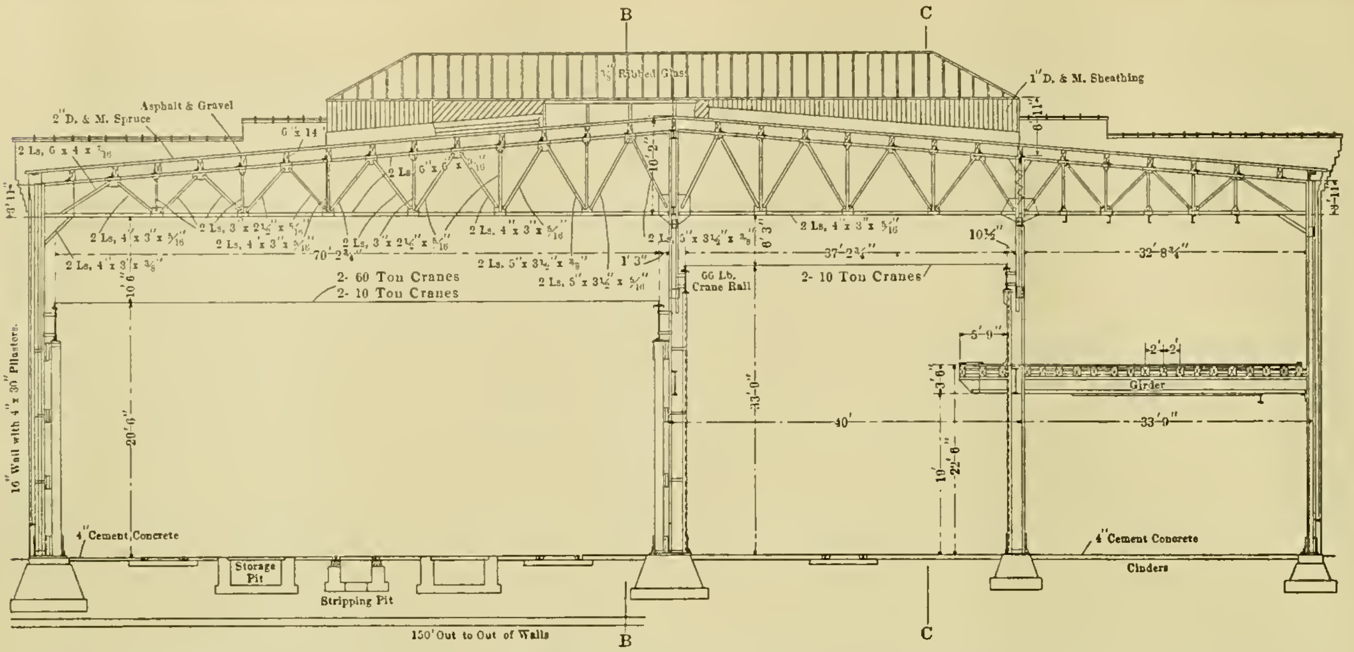
MAIN LOCOMOTIVE SHOP.

A remarkably convenient, open and well lighted structure, encloses the erecting, machine, flue, boiler and tank shops. The steel frame work is shown in detail in the illustrations and is entirely self-supporting. It is enclosed by a brick wall resting on a concrete foundation, continued 5 ft. above grade to the level of the window sills, the sills being formed in concrete. The side walls have practically 50 per cent. lighting area, which, in connection with the skylights, gives unusually good and well distributed natural light throughout the structure.

The building is divided in half longitudinally by the row of columns which support the center of the roof truss, and also carry the runway for the machine shop cranes. Adjacent to these are columns that support the runways for the erecting cranes. The southern half of the building is given over very largely to the erecting work, but also includes the driving wheel work and the tank repairs. Three longitudinal tracks run the full length of this section, and between them are storage pits covered with a removable wooden floor in small sections.

The other half of the building is divided into practically two equal parts by the row of columns which carry the other runway of the 10-ton cranes that serve the heavy machines located in the bay next to the erecting shop. The bay lying between these columns and the outer wall has a gallery which is used for lighter machine work, as is shown on the accompanying insert. This extends about 6 ft. beyond the columns. Below the gallery

* See American Engineer, February and March, 1901.



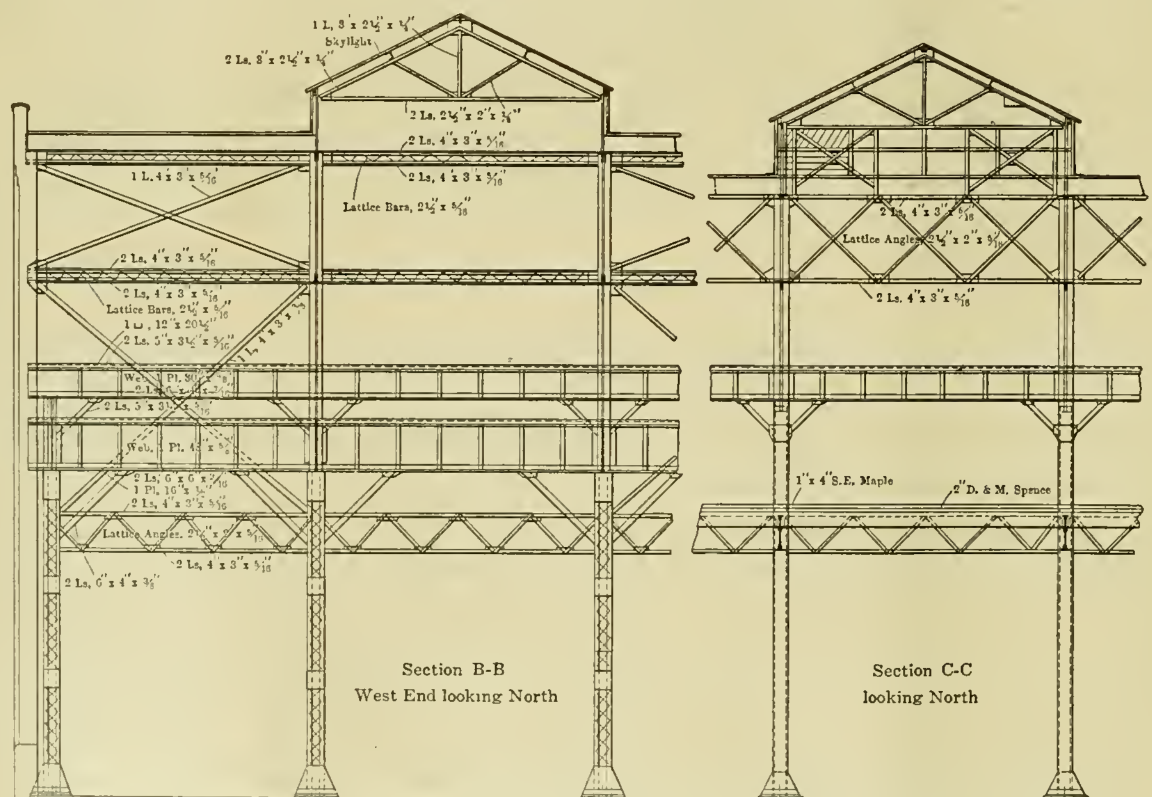
CROSS SECTION OF THE MACHINE, ERECTING AND BOILER SHOP BUILDING. THE SIZE OF THE SKYLIGHTS, DETAILS OF THE ROOF TRUSSES, ARRANGEMENT OF THE GALLERY AND LOCATION OF THE CRANES ARE WELL ILLUSTRATED IN THIS DRAWING.

are grouped the medium weight machines, the arrangement of which is also shown on the insert.

Transverse monitors of a length equal to half the width of the building and 22 ft. wide, covered with heavy ribbed glass, are located 22 ft. apart in the center of alternate transverse bays and furnish light for the inner part of the erecting shop and the heavy machine tool bay.

A 4-inch cement concrete floor laid on cinders is used throughout the whole building. It is formed into square blocks, between each of which there is a strip of tarred paper that will permit the removal and replacement of any blocks that may become broken. Three years' service, however, has shown that this floor is very well suited for its purpose and requires little renewal or repair. It is easily cleaned and allows the trucking of heavy parts if necessary. In front of the various machines and benches, where men stand, removable wooden platforms are laid on top of the cement.

The heating is by the Sturtevant system of hot air carried in concrete ducts under and around the floor next to the outside walls, with numerous discharge openings through risers along all the walls and in the center of the shop. There are four fans, two in fan houses adjacent to the erecting shop and two on



SECTIONAL ELEVATION OF THE STEEL STRUCTURE OF THE LOCOMOTIVE SHOP BUILDING. THIS SHOWS THE CROSS SECTION OF THE SKYLIGHTS LOCATED OVER EVERY SECOND BAY AND GENERAL DETAILS OF THE CONSTRUCTION.

the gallery, so located as to divide the periphery of the building into practically equal parts. The ducts vary in section from 3 ft. x 4 ft. to 3 ft. x 2 ft. 6 in. Manholes to give access to the ducts are provided at ten points and most careful attention has been given to drainage. This system, to the writer's personal knowledge, will provide a comfortable temperature during a blizzard with a very low outside temperature.

General artificial lighting is by Nernst four and six glower lamps over the machine bay and series arc lamps over the erecting floor. Incandescent lamps are used over each machine tool and along the benches. A liberal supply of receptacles along the columns and in the pits are provided for portable lamps and also portable machine tools.

BLACKSMITH SHOP.

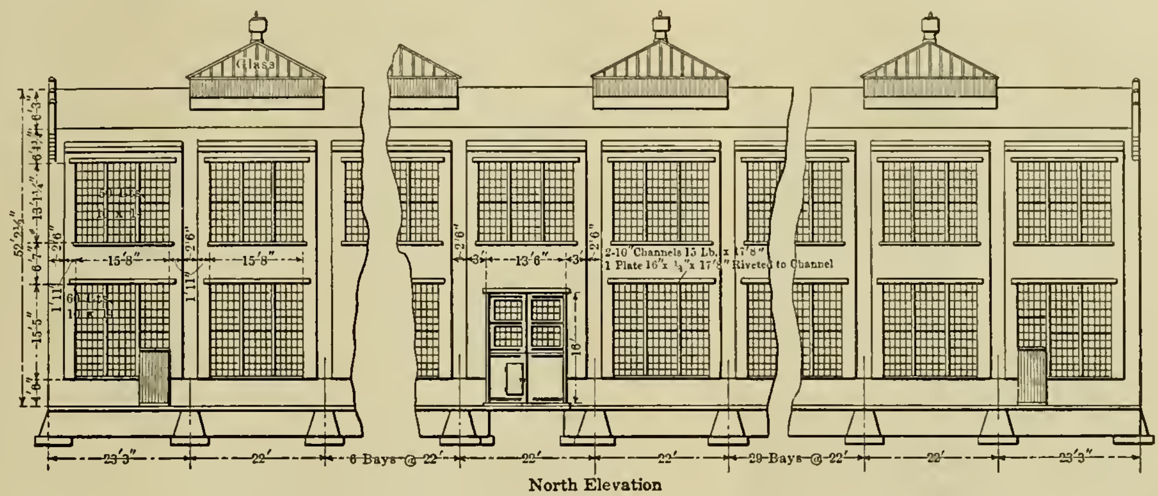
This is a concrete and brick structure with steel roof trusses, having outside dimensions of 80x354 ft. 6 in. A 20 ft. monitor with swinging side lights and a ribbed glass top, which is provided in the center with a continuous lourve, extends nearly the full length of the building. The appearance of the building is similar to the erecting shop, with the exception that the window area provided is not as ample. One of the illustrations give a plan, sectional and elevation view of this building, which illustrates its character very clearly.

The steel work is designed so as to provide ample strength in every direction for jib cranes which may be required to handle heavy weights. Thus at points where cranes are to be located the cross bracing between the roof trusses is carefully studied so as to distribute the stresses over several of them. One of the photographs, showing the interior of the shop, illustrates this construction clearly and shows how the cranes are arranged.

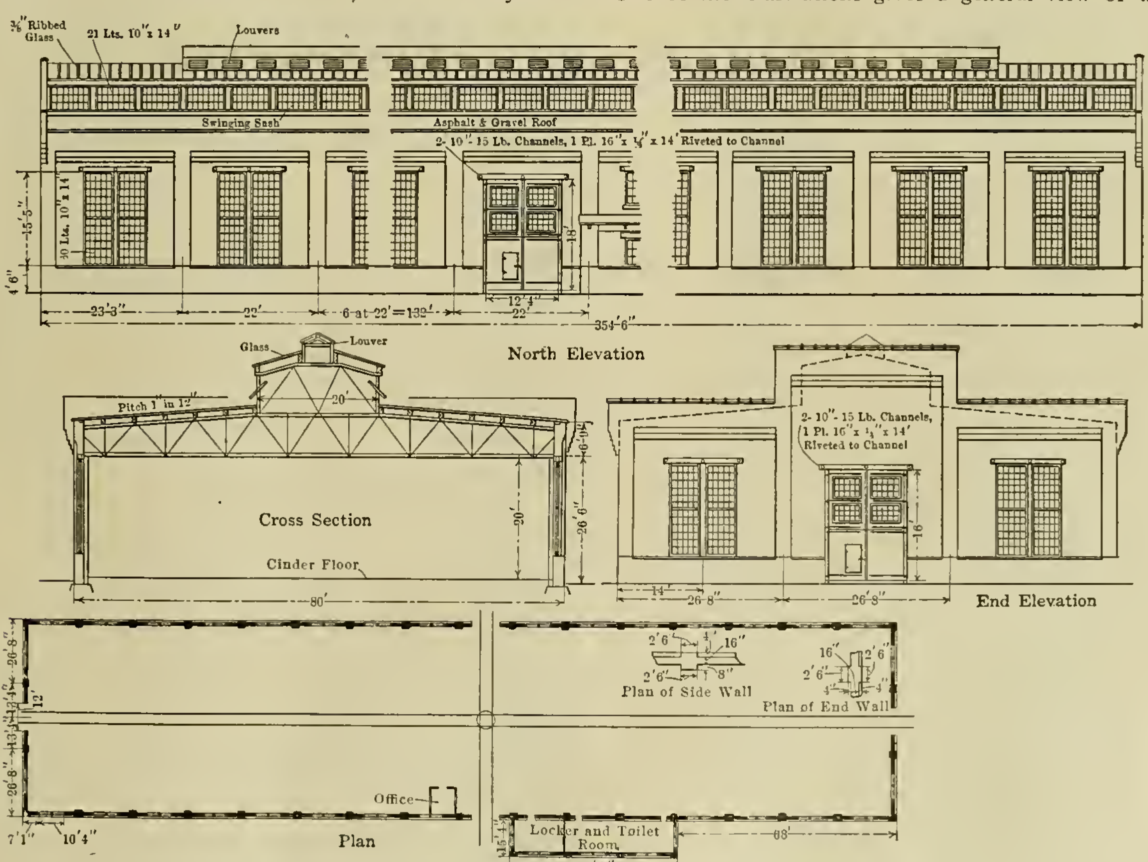
Cinders are used for flooring throughout the whole shop and the artificial lighting is by Nerst glowers, the same as in the machine shop. A Sturtevant fan furnishes air pressure for the forges, the ducts being carried beneath the floor.

IRON SHED.

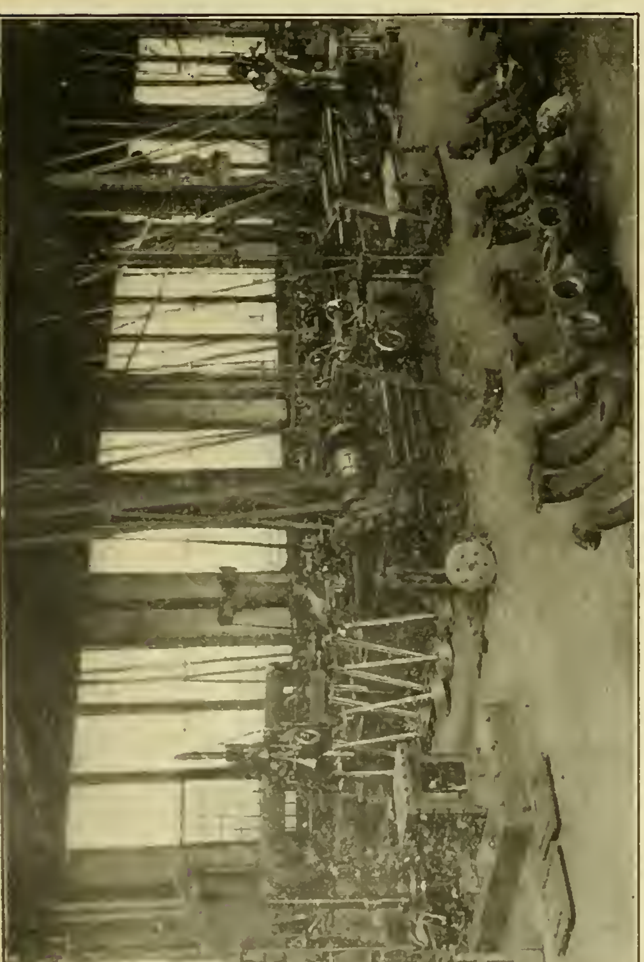
One of the illustrations gives a general view of the building



SIDE ELEVATION OF THE LOCOMOTIVE SHOP BUILDING. THE VERY LARGE LIGHTING AREA AND GENERAL ATTRACTIVE APPEARANCE OF THE BUILDING ARE EVIDENT HERE.

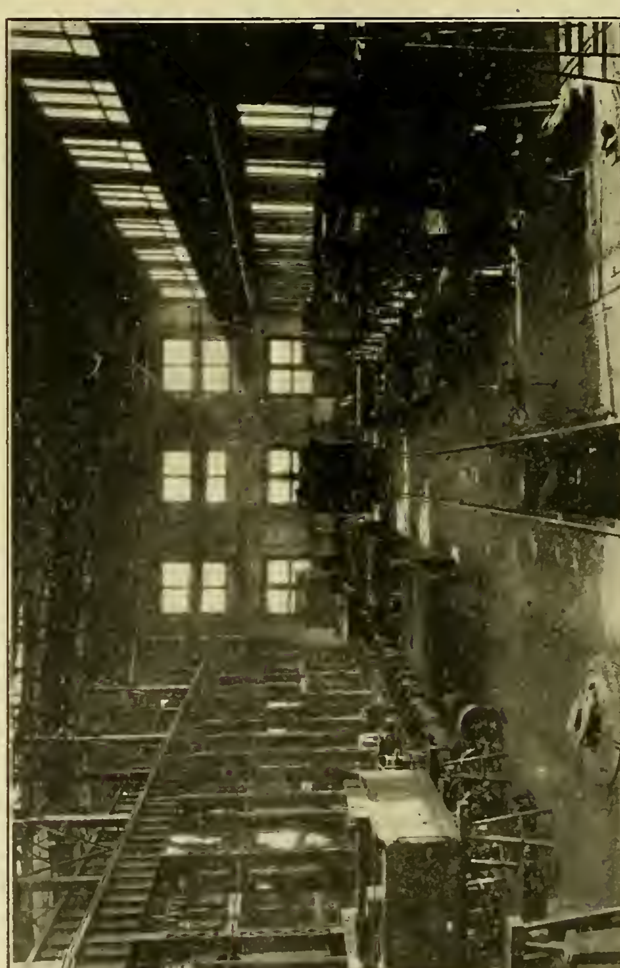


ELEVATIONS, PLAN AND SECTION OF THE BLACKSMITH SHOP BUILDING. THE LONGITUDINAL SKYLIGHT WITH VENTILATORS SIDE AND TOP EXTENDS NEARLY THE FULL LENGTH OF THE BUILDING.

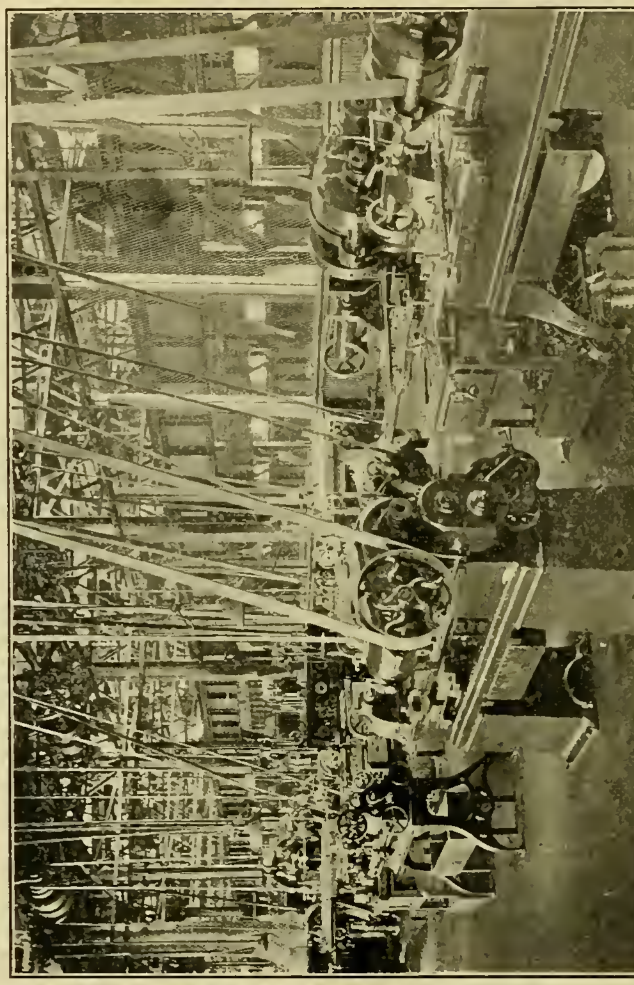


VIEW TAKEN FROM POINT H SHOWING THE PISTON AND PISTON ROD GROUP. THE TOOLS IN THE FOREGROUND ARE SERVED BOTH BY THE 10-TON TRAVELING CRANES AND BY THE AIR HOISTS OR JIB CRANES, TWO OF WHICH APPEAR IN THE ILLUSTRATION. PARTICULARLY GOOD NATURAL LIGHTING IS EVIDENT IN THIS PICTURE.

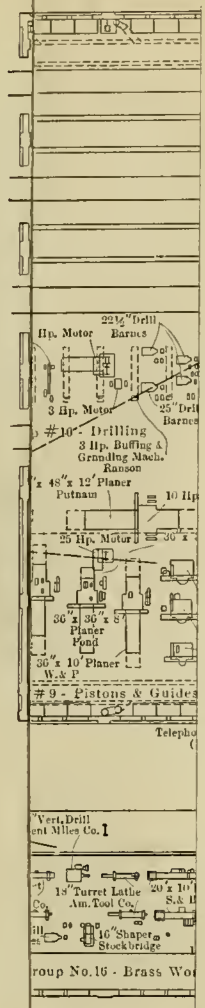
LOOKING FROM POINT G ON THE BALCONY INTO PART OF THE HEAVY MACHINE SHOP SECTION SHOWING METHOD OF COUNTER-SHAFT SUPPORT; WORK BENCHES BETWEEN THE COLUMNS; AIR CRANES; SOME OF THE LARGE TOOLS AND THE VERY NOTICEABLE ORDERLINESS AND CLEANLINESS OF THE SHOP.



VIEW TAKEN FROM POINT C SHOWING THE TANK REPAIR SECTION. TANKS ARE REPAIRED ON ONE PIT; THE UNDER-FRAMES BETWEEN THE PITS AND THE TRUCK ON THE PIT NEXT TO THE BOILER SHOP.



VIEW SHOWING THE TOOL ROOM ON THE BALCONY. THE MACHINES SHOWN ARE ALL DEVOTED TO THE MANUFACTURE OF TOOLS FOR THE SHOP.



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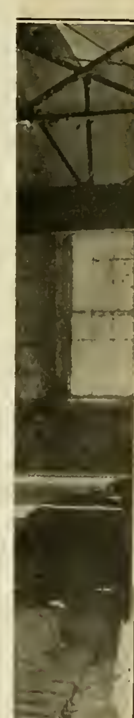

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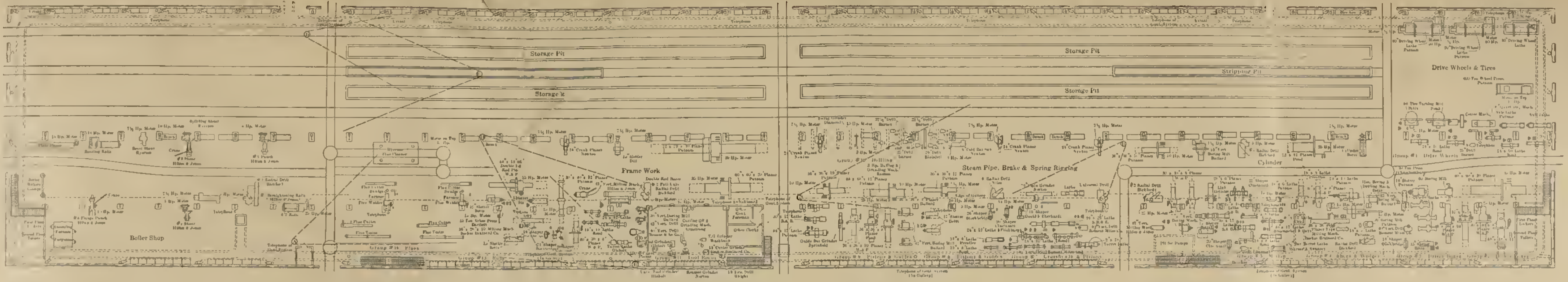
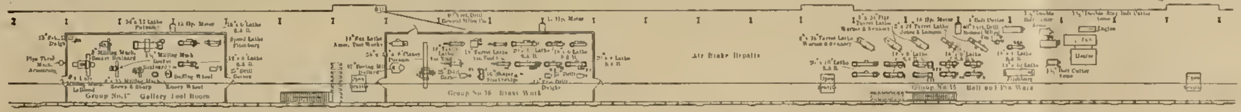


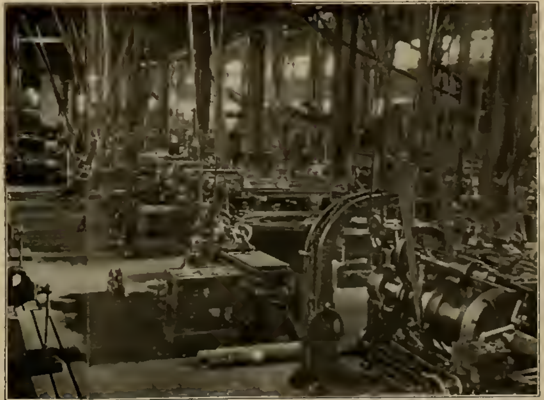
READVILLE LOCOMOTIVE SHOP
OF THE
NEW YORK, NEW HAVEN AND HARTFORD RAILROAD



GENERAL PLAN OF ERECTING, MACHINE AND BOILER SHOPS, SHOWING LOCATION OF MACHINE TOOLS

VIEW TAKEN FROM POINT D SHOWING THE ROD GROUP. THE MACHINE IN THE FOREGROUND IS A DOUBLE HEADED PLANER WITH FOUR CUTTER HEADS. THE CONE PULLEY, WHICH APPEARS TO BE PART OF IT, BELONGS TO THE SLOTTER JUST BEHIND IT.

VIEW TAKEN FROM POINT B SHOWING THE GENERAL ERECTING SHOP. IT WILL BE NOTICED THAT THE LOCOMOTIVES ARE SET STAGGERING, SO AS TO PERMIT THE EASY REMOVAL OF THE FLUES. THIS VIEW GIVES AN EXCELLENT IMPRESSION OF THE GENERAL APPEARANCE OF THE SHOP.



VIEW TAKEN FROM POINT E SHOWING PART OF THE TOOLS DEVOTED TO ROD WORK. THIS IS UNDER THE BALCONY AND THE TROLLEY AIR HOISTS ARE INDISTINCTLY SHOWN. ONE OF THE TELEPHONES TO THE TOOL ROOM WILL BE NOTICED ON ONE OF THE COLUMNS IN THE CENTRE DISTANCE.

VIEW TAKEN FROM POINT A SHOWING THE FLUE SHOP. AT THIS POINT ALL FLUES ARE CLEANED, CUT-OFF, SAFE ENDED AND TESTED. IT WILL BE NOTICED THAT THE EQUIPMENT IS IN DUPLICATE WITH THE EXCEPTION OF THE RATTLER.

VIEW SHOWING THE IRON STOCK HOUSE LOCATED JUST OUTSIDE OF THE BLACKSMITH SHOP. THE SHEAR FOR CUTTING OFF THE STOCK IS SHOWN AT THE LEFT AND PORTABLE SCALES IN THE FOREGROUND. A COMPLETE STOCK OF BAR IRON IN COMMERCIAL SIZES IS MAINTAINED IN THIS BUILDING UNDER THE CHARGE OF A STOREHOUSE EMPLOYEE.

located just outside the blacksmith shop, which is used for the storage of bar iron stock. This is a wooden structure fitted with sliding doors in front, the runways of which are so arranged that practically the whole front of the building can be opened up. The racks are of very heavy timber and are marked so that each kind of stock is easily identified. They occupy about two-thirds of the building. Alongside of the racks is an electric driven shear and a portable scale forms part of the equipment. This building is in charge of a storehouse employee, who cuts off, weighs and delivers such material as is ordered on requisition from the foremen. No one is allowed to remove any stock without authority, nor to do his own shearing.

CLEANING HOUSE.

One of the most noticeable features of the whole shop is its remarkable cleanliness. This is due partially to the practice of completely dismantling the locomotive on the stripping pit, which permits the comparatively easy wiping of different parts, but more to the excellent facilities provided for cleaning with the lye vats and the arrangement whereby this is done outside of the shop proper.

A steel framework supporting wooden sides and roof covers two large vats, each provided with large draining platforms. The vats are 18 ft. 6 in. by 10 ft. inside dimensions; the least depth is 7 ft. They are constructed with heavy concrete sides and bottom and are separated by the track which passes through this building into the erecting shop. Alongside each tank is a concrete platform with a decided slope into the tank, covered by a grating of 3 x 6 in. yellow pine strips spaced 2 in. apart upon a framework of 4 x 4 in. spruce joists.

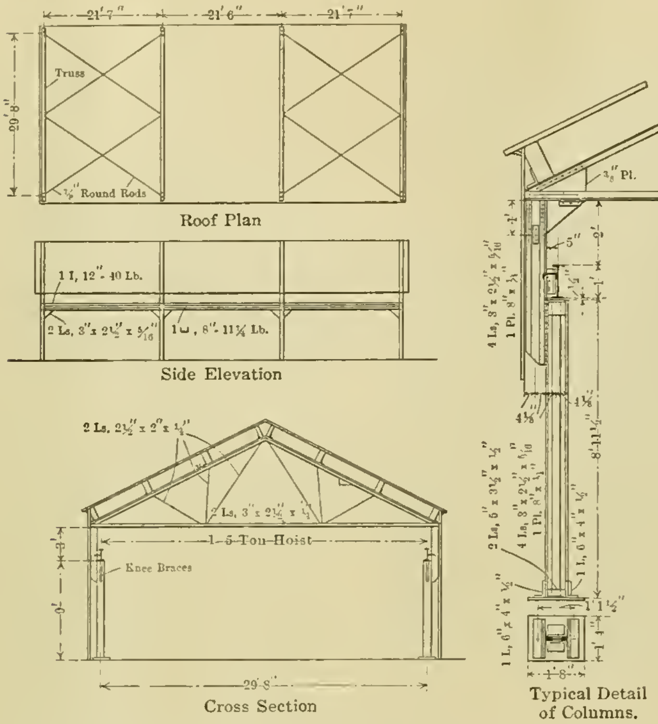
A 5-ton air operated hoist carried upon a traveling girder having a span of nearly 30 ft., handles the parts from the push cars on the center track, into and out of the vats or the drainage platform. One of the photographs shows an interior view that illustrates the construction of the steel framing and arrangement of this traveling hoist. The floor around the vats and platform is of macadam. The walls of the vats are 18 in. thick and the bottom is 9 in. thick. They were originally waterproofed with a soft soap and alum solution, but it was soon found that the absorption of the oil from the greasy parts put into the vat provided a waterproofing of the very best kind. The top of the vats are covered with large wooden doors handled by the hoist. The room provided in this house is so ample that the usual litter of dirt and greasy parts is nowhere in evidence.

The steel columns supporting the crane runway are built up of angles and plates and carry a 12-inch, 40-pound, I-beam reinforced by an 8-inch channel. These columns are spaced 21 ft. 7 in. apart and to them are riveted on the outside a short strut of similar construction, which carries the simple design of steel roof truss. The enclosing structure is of the simplest character of wooden construction ,with sliding doors on either side where the track passes through the building. Two large ventilators are provided in the roof.

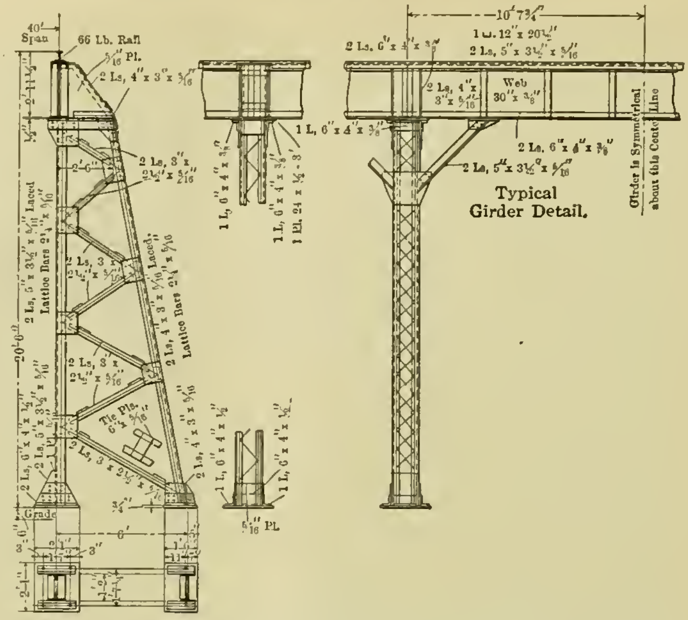
TIRE HOUSE.

All work of removing and replacing tires is done in a separate structure alongside the erecting shop, into which runs a 10-ton crane that covers the storage platform and tracks outside the

VIEW SHOWING THE INTERIOR OF THE CLEANING HOUSE. THE TRAVELING AIR HOIST, LARGE SIZE OF THE TANKS AND DRAINING PLATFORM, AS WELL AS THE STEEL FRAME WORK OF THE BUILDING, ARE WELL ILLUSTRATED BY THIS VIEW. THE HEAVY DOORS COVERING THE VATS ARE HANDLED BY THE HOIST.



GENERAL PLANS AND DETAIL OF COLUMNS OF THE STRUCTURE OVER THE LYE VATS. THIS STEEL FRAME IS ENCLOSED BY A WOOD SHELL. THE METHOD OF SUPPORTING AND BRACING THE CRANE RUNWAYS IS CLEARLY SHOWN IN THIS VIEW.



DETAILS OF THE RUNWAY SUPPORTS OF THE FORTY FOOT CRANE THAT COVERS THE STORAGE YARD AND ALSO ENTERS THE TIRE HOUSE.

building. This structure is of steel frame work enclosed with corrugated iron, the details of construction being shown in one of the illustrations. Swinging doors, operated by means of a wire cable, cover the space provided for the entrance of the crane. The columns supporting the crane runway over the tire platform and storage yard are also shown in detail in one of the illustrations. They are arranged to give a 40-ft. clear span to the crane, the top of the rail being 21 ft. above grade. The runway has a total length of 127 ft. 9 in.

The track passing into this building extends through the erecting shop and into the machine shop, where it is provided with a turntable on one of the longitudinal tracks. A Ferguson oil heater is fitted in the bottom of a sunken heating pit, with a capacity for heating eight tires at one time. On the opposite side of the track are oil heaters, arranged at the floor level, for removing tires. A pair of wheels, if the tires only are to be removed, are set with the axle in the vertical position between the burners, the handling being done by the crane. Transportation to and from the erecting shop is by push cars, the location of the tire house being just outside of the section devoted to the driving wheel work.

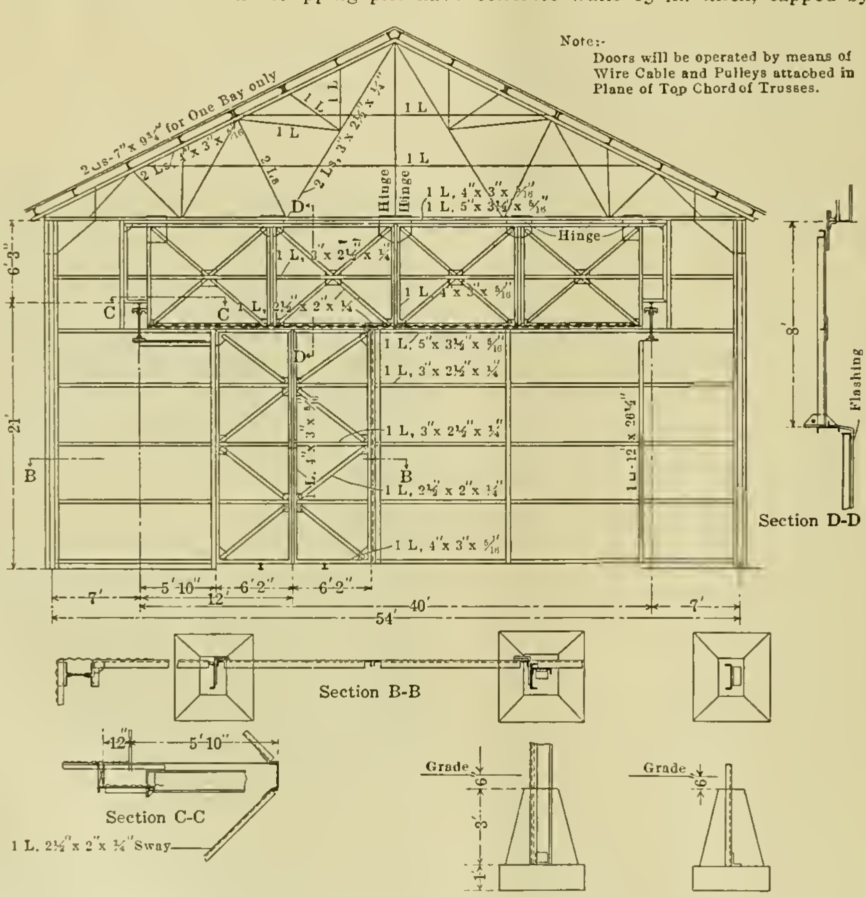
GANTRY CRANE.

For unloading the coal from tenders, loading ashes from blacksmith shop, removing tender trucks or other work of this character, a traveling Gantry crane spanning three tracks is provided in the yard near the blacksmith shop. This crane is fitted with a clam shell bucket for handling coal or similar material and is electrically operated. It has a capacity of five tons. One of the illustrations shows its general appearance.

ERECTING SHOP.

About two-thirds of the floor space beneath the 60-ton crane runway is used for the erecting floor; the remainder is given up to the driving wheel work, which occupies about 100 ft. at one end and the tank and boiler shop work which occupies 188 ft. at the opposite end. The erecting shop is of the longitudinal type, having three tracks. None of these tracks are provided with pits with the exception of about 150 ft. at either end of the center track, which location is used for stripping at one end and for wheeling at the other. Throughout the rest of the shop the floor between the rails is at the same level as that outside.

The stripping pits have concrete walls 15 in. thick, capped by



ELEVATION AND DETAILS OF THE STEEL FRAME OF THE TIRE HOUSE. THIS IS COVERED WITH CORRUGATED IRON SHEATHING. A SWINGING DOOR OPERATED BY WIRE CABLES COVERS THE OPENING OVER THE RUNWAYS WHERE THE TRAVELING CRANE ENTERS. THE BUILDING DOES NOT SUPPORT THE RUNWAYS IN ANY WAY.

yellow pine stringers secured by anchor bolts. These pits drain to two sumps with cast iron gratings, located 50 ft. apart.

Between the longitudinal tracks are storage pits extending the full length of the erecting shop, with the exception of a 20 ft. passageway in the center. These pits are 6 ft. in width, built entirely of concrete, with walls 12 in. thick. They are 2 ft. 10 in. deep at the ends and slope longitudinally each way to traps for drainage. The maximum depth is 5 ft. They are covered by 4x12 in. yellow pine planks, every tenth plank being provided with an extra heavy pair of malleable iron handles set flush with the surface.

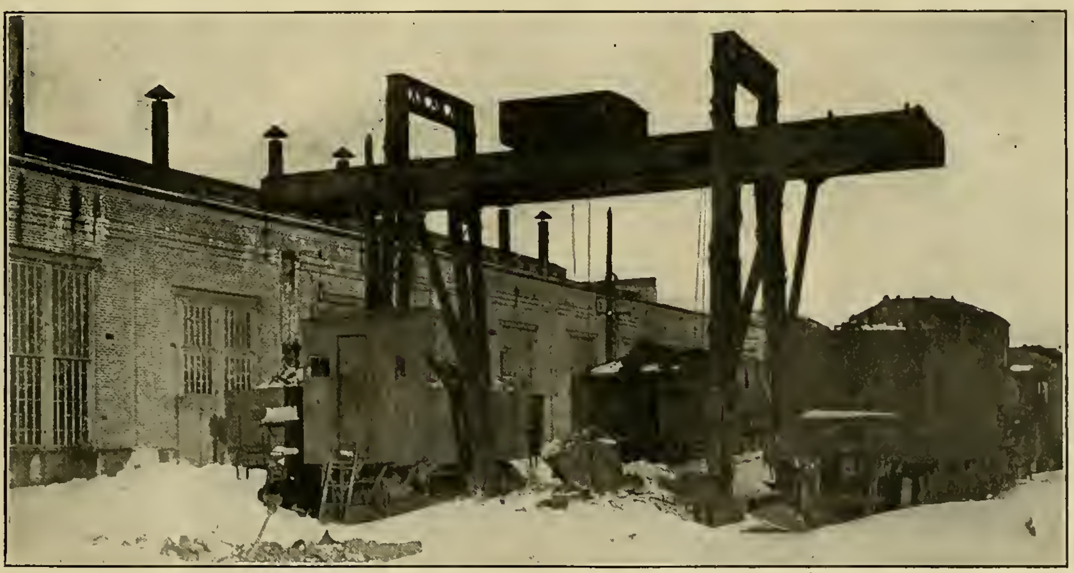
Work benches line the entire outer wall of both the erecting and machine shop and are also conveniently located in the bays between the center line of columns, as is shown in the large general plan. The floor is served by two 10-ton cranes and two 60-ton cranes, each of the latter having 10-ton auxiliary hoists.

LOCATION AND ARRANGEMENT OF THE MACHINE TOOLS.

In the machine shop, which occupies about one-half of the main building, the tools are arranged so that the work on any one part, or of a similar character, is completed in one section of the shop. When a part is delivered to the shop for repairs, or the rough material for a new piece, it is completed and assembled in all its details without leaving the same vicinity. An exception to this is found in the case of tires, which are applied and removed in the building just outside of the main shop.

As is seen from the illustration of the cross section and from several of the photographs, the gallery covers about one-half of the machine shop space and below it are grouped most of the medium weight tool equipment, while the heavier tools are placed beyond the gallery, where they can be served by the 10-ton cranes. These larger tools are, as a general rule, driven direct from motors attached to the machine or located near by. The smaller tools are all group driven, being belted from a line shaft that is carried from the floor of the gallery and is continuous from one end of the shop to the other, being separated into sections as the arrangement of the machines and size of the motor dictates. Each of these sections is also divided into two parts by a flange coupling and there is also flanged coupling on the ends of the shaft at each section, which are in alignment and spaced

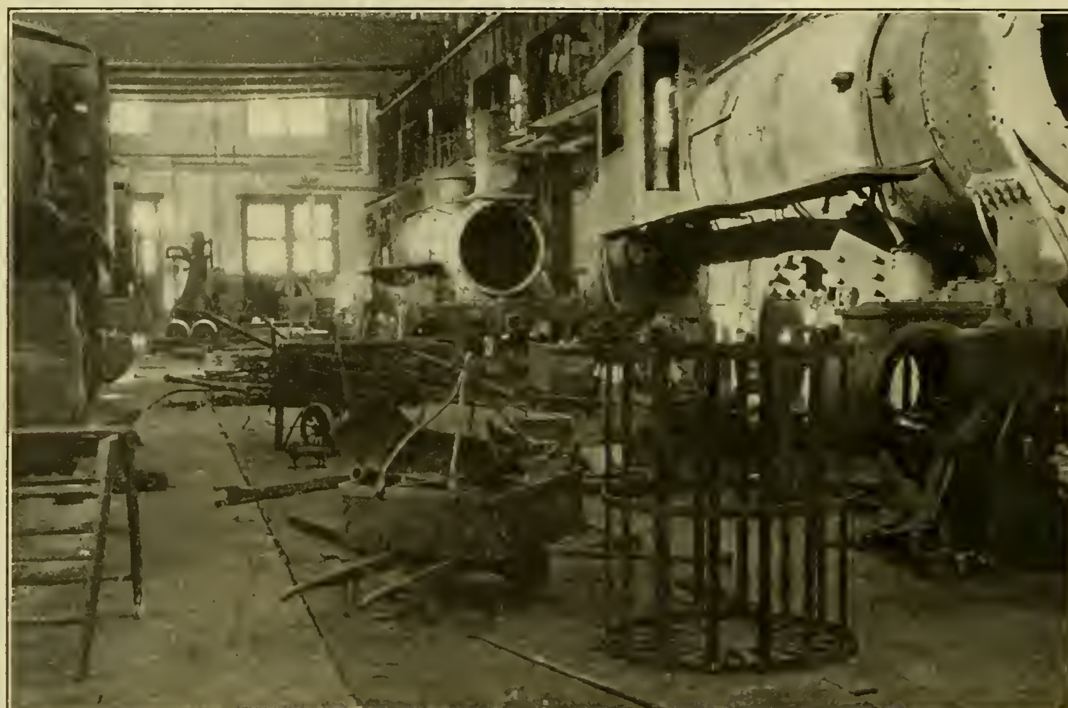
VIEW SHOWING THE TIRE HOUSE AND STORAGE YARD. WHEEL CENTRES AND OTHER HEAVY CASTINGS ARE UNLOADED FROM THE CARS TO THE CONCRETE PLATFORMS UNDERNEATH THE CRANE, WHERE THEY ARE STORED UNTIL NEEDED. ALL REMOVING AND APPLYING OF TIRES IS DONE IN THE BUILDING SHOWN AT THE LEFT.



VIEW SHOWING THE GANTRY CRANE USED FOR UNLOADING TENDERS, LOADING SCRAP CARS, ETC. THE BUILDING IN THE BACKGROUND IS THE BLACKSMITH SHOP.

one-half inch from a similar coupling on the next section. Thus, in case of a breakdown of a motor in any group it is only necessary to insert a half inch filling piece and the bolts in the coupling to the next group on either side and remove them from the center coupling to permit the motors on the groups adjacent taking up the load of the disabled section. The shafts for each group average about 44 ft. in length. The motors are located on brackets supported by the inner row of columns.

Referring to the illustration on the accompanying insert, which shows the location of the tools in the machine, boiler and erecting shop, it will be seen that four bays at the western end of the shop under the erecting shop cranes are, with the exception of the center track and considerable space on either side for storage, given up to the driving wheel work. Here are located two large 90-inch Putnam lathes of the most modern type, in addition to an 80-inch older lathe, all placed along the southern wall. Opposite these are two 84-inch boring mills for turning tires, one a Betts and the other a Pond; a 90-inch quartering machine and two large axle lathes. The 600 ton Putnam wheel press is placed near the center track, so that the wheels can be delivered and removed by this route. For crank pins and axles there are five 24 inch by 10 ft. Reed lathes grouped just inside of the row of columns and driven by a 25 h. p. motor belted to a line shaft. This forms group No. 1. A 24-inch Barnes drill and a cotter machine, for drilling keyways, etc., are also located in the same group.



VIEW SHOWING THE VICINITY OF THE STRIPPING PITS. THE BASKETS ARE FOR CONVEYING THE PARTS TAKEN FROM THE LOCOMOTIVES TO THE LYE VATS AND ARE OF MANY DIFFERENT SIZES AND SHAPES. THE ONE IN THE IMMEDIATE FOREGROUND IS FOR BOILER JACKETS. THE PARTS AFTER CLEANING ARE RETURNED TO THE SHOP IN THE SAME BASKETS.

Groups two and three, located underneath the gallery directly opposite group one, are given up to driving box work. They include a large 60x60 in. by 20 ft. Putnam planer direct driven by a 35 h. p. motor and four smaller planers belted from the line shaft, driven by a 25 h. p. motor. From the same shaft are also driven three 24 in. x 10 ft. Reed lathes; a 42-inch Bullard boring mill, and also a 60-inch boring mill that was transferred from the Norwood shops. A 5 ft. Bickford radial drill; 40-inch vertical drill; two slotters; 24-inch shaper, as well as two horizontal Betts boring and drilling machines, a 36-inch Putnam boring mill, and a small Putnam lathe, although belted to group four, are used for this work.

Group four is for new shoe and wedge work and includes a large 26x26 in. by 10 ft. Becker-Brainard planer type milling machine and two 30 x 30 in. x 8 ft. Woodward & Powell planers. This group is driven by a 15 h. p. motor.

Repairs to motion work are done in groups five and six, driven by a 15 and 25 h. p. motor, respectively. These two groups include nine lathes of various sizes; a turret lathe, 22-inch double Cincinnati shaper, 20-inch Cincinnati shaper, three planers, No. 2 Bickford drill, 37-inch Baush boring mill, 15-inch slotter, 42-inch vertical milling machine, a link grinder and a small 25-inch drill.

Opposite groups 4, 5 and 6, beneath the craneway and next to the center row of columns, are located a 72-inch by 12- ft. Pond planer driven by a 25 h. p. motor, a No. 3 Bickford drill driven by a 5 h. p. motor, a 51-inch Bullard vertical boring mill driven by a 7½ h. p. motor, a 36 x 36 in. by 10 ft. Putnam planer driven by a 10 h. p. motor and a cylinder boring machine driven by a 7½ h. p. motor, which are used for cylinder work. There is considerable open floor space around these machines and in this vicinity.

In the next three groups 7, 8 and 9, the work on cross heads, pistons and guides is done. In these groups, which are driven by 15 h. p., 10 h. p. and 25 h. p. motors, respectively, are found the following tools:

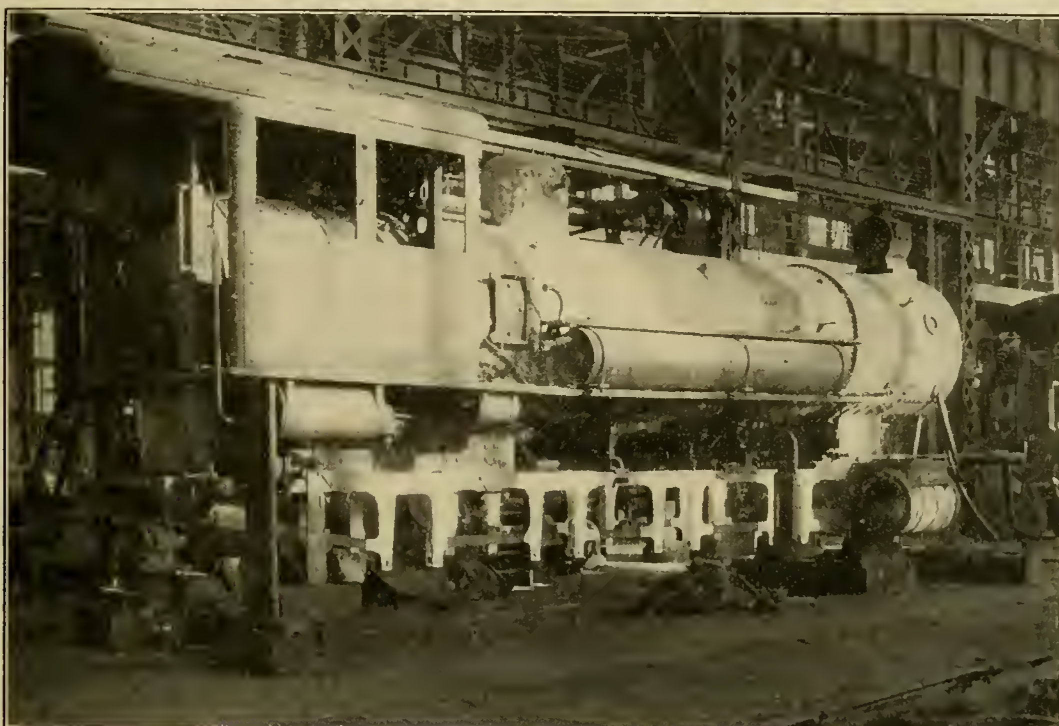
Three 24 in. by 12 ft. Reed lathes.
2 in. by 24 in. turret lathe.
Two 40 in. Bement Miles vertical drills.
24 in. by 22 ft. Schumacher & Boye lathe.
24 in. by 12 ft. Fitchburg lathe.
Two 18 in. by 8 ft. Reed lathes.
18 in. by 8 ft. Prentice lathe.
72 in. Norton plain grinder.
Two shapers, one Stockbridge (26 in.) and one Cincinnati (20 in.).
16 in. Gould & Eberhardt shaper.
72 in. Niles radial drill, direct driven by 3 h. p. motor.
Two 12 in. Betts slotters.
Three 42 in. Bullard boring mills.
Three 36 by 36 in. by 10 ft. planers, two Woodward & Powell and one Pond.
Springfield guide bar grinder.
Two 30 in. by 12 ft. Schumacher & Boye lathes.
34 in. by 12 ft. Putnam lathe.
36 in. by 36 in. by 10 ft. Putnam planer, driven by a 10 h. p. motor.
48 by 48 in. by 12 ft. Putnam planer, 10 h. p. motor.
36 by 36 in. by 12 ft. Putnam planer, 7½ h. p. motor.

It will be noticed that these tools are grouped so as to leave a wide open space in the center of the groups and between the benches and the tools.

Opposite group 9 is group 10, which is given up to miscellaneous drilling and contains nine drills of sizes from 22½ to 28 in., in addition to a direct driven 4-in. Newton cut-off saw, a buffing and grinding machine driven by a 3 h. p. motor and a swing grinder. This group is placed between the column next to the erecting shop and its line shaft is carried by brackets supported from the columns, the arrangement of which will be seen at the left hand side of the view taken from point G. The group is driven by a 15 h. p. motor.

Following along under the craneway we next come to two very large planers used for planing frames. One is a 72 x 72 in. by 30 ft. Putnam machine driven by a 35 h. p. motor, and the other is a 60 x 60 in. by 20 ft. Putnam planer, also driven by a 35 h. p. motor. Adjacent to the latter is a 15 in. Dill slotter driven by a 7½ h. p. motor. Opposite the larger planer and under the gallery is the general foreman's office, adjacent to which is the distributing tool room. The number of small tools in this section form group 11, driven by a 15 h. p. motor.

Just beyond the tool room come groups 12 and 13, where the rod work is done. Two of the photographs taken from points D and E show the appearance of this section of the shop very



LOCOMOTIVE AS IT COMES FROM THE STRIPPING PIT. IT WILL BE NOTICED THAT IT IS THOROUGHLY STRIPPED AND THOROUGHLY CLEANED. THE PEDESTALS ARE PAINTED A GLISTENING WHITE BEFORE THE LOCOMOTIVE IS LIFTED BY THE CRANE AND THIS OPERATION, TOGETHER WITH A FEW BLOWS OF A HEAVY SLEDGE WILL MAKE ALL CRACKS CLEARLY EVIDENT.

clearly. The tools comprising these groups are as follows:

No. 2 full universal Bickford drill, 5 h. p. motor.
48 by 18 in. by 16 ft. Woodward & Powell double headed rod planer, 15 h. p. motor.
Two 30 in. Bullard boring mills.
42 in. Prentice vertical drill.
40 inch Bement Miles vertical drill.
Gisholt turret lathe.
Double rod borer.
42 inch Hilles & Jones vertical milling machine.
Two 24 in. by 12 ft. Reed lathes.
Two 18 in. by 8 ft. Reed lathes.
30 by 30 in. by 8 ft. Woodward & Powell planer.
20 in. Cincinnati shaper.
24 in. Stockbridge shaper.
16 in. Stockbridge shaper.
Two 15 in. Betts slotters.
26 by 26 in. by 10 ft. Becker Brainard milling machine.
12 inch Betts slotter.
5 ton arbor press.

It will be noticed that there are a number of direct driven 24-inch Newton crank planers located alongside of the columns adjacent to the erecting shop and scattered throughout the length of the building. These planers are used for facing shoes and wedges after they have been fitted to the locomotives and marked for facing. These machines serve the pits in their immediate vicinity and avoid the necessity of transporting these parts from all over the large erecting shop to one point. The same planers when they are not engaged for shoe and wedge work may be used for any miscellaneous emergency work that may be required.

On the gallery is done some light machine work and the repairs, such as cabs and air pumps, that require considerable floor space. It is provided with four extensions, which permit the transfer of material by means of the 10-ton cranes over the heavy machine bay. There is also a runway of single I-beams supported from the roof trusses and located near the outer wall, on which there are two 1½ ton electric hoists. A number of openings or hatchways through the gallery floor permit these hoists to handle material from the floor below to any part of the gallery, or vice versa. There is a similar runway with three hoists underneath the gallery just in front of the benches.

Beginning at the west end of the gallery, there is first a large wash room, then a section with benches and clear space for light electric and machine repairs; following this comes machines for bolt and pin work, arranged as group 15 and driven by a 15 h. p. motor. This group contains the following tools:

24 in. by 10 ft. Fitchburg lathe.
Two 20 in. by 10 ft. Schumacher lathes.
Four 18 in. by 8 ft. Prentice lathes.
Five 18 in. by 6 ft. Schumacher lathes.
Three 2 in. by 24 in. Warner & Swasey flat turret lathes.
Two 2 in. by 24 in. Jones & Lamson flat turret lathes.
40 in. Bement vertical drill.
3 in. bolt cutter.
1½ in. Acme bolt cutter.
1½ in. Acme double bolt cutter.
1½ in. Acme double staybolt cutter.

Beyond this group are benches, racks and other equipment for repairing air pumps, triple valves, etc. Then comes a space enclosed by heavy wire netting where all of the brass work is done. These machines form group 16, driven by a 15 h. p. motor, and include the following tools:

Two 20 in. by 10 ft. Schumacher & Boye lathes.
20 in. by 8 ft. Schumacher & Boye lathe.
Three 18 in. by 6 ft. Schumacher & Boye lathes.
Four 18 in. Fox lathes (American Tool Works Co.).
18 in. Fox turret lathe (American Tool Works Co.).
24 in. by 8 ft. Putnam planer.
40 in. Bement vertical drill.
Three 25 in. Barnes vertical drills.
13 in. Dwight friction drill.
37 in. Bullard boring milll.
16 in. Stockbridge shaper.

The next group is 17, driven by a 15 h. p. motor, and includes the machines for manufacturing tools. This space is also enclosed by heavy wire netting. Beyond this is the pipe shop, followed by the tin shop, which in turn is followed by the carpenter and paint shop, where cab work, making running boards, etc., is done. At the east end of the gallery is another wash room.

BOILER SHOP.

The east end of the section of the building otherwise devoted to the machine shop is used by the boiler shop, the flue work occupying the space just next to the rod gang, the machines being arranged to form group 14. In this group are two complete outfits for cutting-off, safe ending, swaging and testing flues. Alongside of them, beneath the craneway, is a depressed Ryerson flue cleaner, driven by a 25 h. p. motor. Group 14 has a 10 h. p. motor.

Between the flue and boiler shop is a transverse track which continues through the building and to the outside on either side, being provided with turntables connecting to the longitudinal tracks, one of which passes over the flue cleaner and the other alongside of the flue tester.

In the boiler shop are the following machines:

No. 3 Hilles & Jones straightening roll.
No. 5 Hilles & Jones punch driven by a 5 h. p. motor.
No. 4 Hilles & Jones shear driven by a 10 h. p. motor.
Ryerson bevel shear driven by a 7½ h. p. motor.
No. 3 Bickford radial drill driven by a 5 h. p. motor.
Ryerson splitting shears driven by a 7½ h. p. motor.
No. 3 Hilles & Jones shear driven by a 5 h. p. motor.
Set of bending rolls driven by a 10 h. p. motor.
Plate planer, 10 h. p. motor.
Hilles & Jones flange punch, 10 h. p. motor.
Ferguson annealing furnace.
Set of boilermakers clamps.

TANK SHOP.

Tanks, underframes and trucks are repaired at the east end of the erecting shop. It is necessary to keep the center track at this point clear in order to permit the exit of finished locomotives, therefore tenders are brought in on one of the side tracks; the underframe is lifted from the trucks by the crane and set upon low horses between the tracks. The tank is then removed from the underframe and set upon high horses that permit working on the bottom sheets. These are usually over one of the side tracks. This arrangement is shown in the photograph from point C and permits the convenient repair of all three parts of the tender simultaneously. It is the custom of the shop to remove and repair the tanks of every tender coming in and a leaky tank going out of the shop is unknown.

BLACKSMITH SHOP.

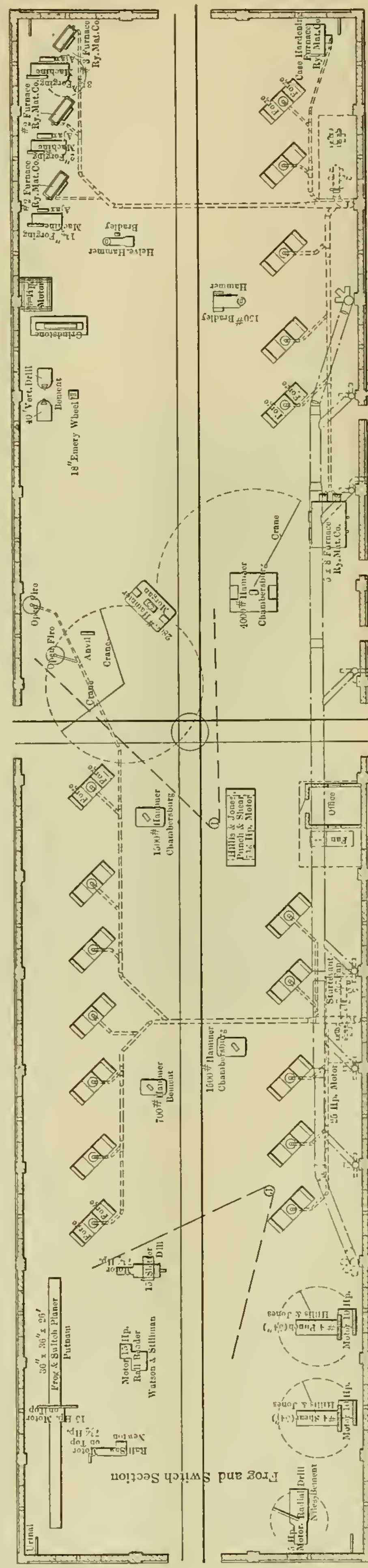
The blacksmith shop proper contains seventeen double forges, a 700 pound steam hammer, two 1,500 pound steam hammers, a 2,800 pound steam hammer and a 4,000 pound steam hammer, in addition to a large punch and shear, open fires and a large oil furnace. There is also at the opposite end of the shop, near the five double forges there located, a Bradley hammer and a Helve hammer.

The forge shop contains three Ajax forging machines, one 1½ inch, one 2 inch, and one 3½ inch, with Ferguson furnace adjacent. These machines, in addition to the grindstone, emery wheel and two 40-inch vertical drills, are driven from the line shaft connected to a 75 h. p. motor; the Helve hammer also connects to the same shaft. It will be noticed that a liberal amount of floor space has been left in front of the forging machines in this section of the shop for storage of raw material and finished forgings.

FROG AND SWITCH SHOP.

The east end of the blacksmith shop building is given up to tools and floor space for making and repairing frogs and switches. The tools are all direct driven and consist of a large 36 x 36 in. by 20 ft. Putnam frog and switch planer driven by a 15 h. p. motor, Newton rail saw, 7½ h. p. motor, Watson & Stillman rail bender, 15 h. p. motor, 15 in. Dill slotter, 7½ h. p. motor, 5 ft. 6 in. Niles radial drill, 5 h. p. motor, and two No. 4 Hilles & Jones shears, each driven by a 10 h. p. motor.

Each of these machines is served by jib cranes, which are arranged to overlap and permit the easy handling of all material from the track cars to and from the different machines. A gen-



PLAN OF BLACKSMITH SHOP SHOWING THE LOCATION OF TOOLS, FORGES AND OTHER EQUIPMENT.

VIEW TAKEN FROM POINT I SHOWING A SECTION OF THE BLACKSMITH'S SHOP. THE CRANE COVERING A FULL CIRCLE, IS SUPPORTED ENTIRELY FROM THE ROOF AND SERVES A LARGE HAMMER, LARGE FORGE AND FACE PLATE AND TWO TRACKS. THE EXCELLENT OVERHEAD LIGHTING IS EVIDENT IN THIS PICTURE.

eral view of part of this shop is shown in the photograph taken from point J.

TELEPHONE SYSTEM.

There is a general telephone system connecting all of the different offices throughout both the locomotive and car shops, which also has a connection to the regular Bell system. These 'phones are located at convenient points throughout all of the buildings, so that connection can be had with the shop superintendent, general foreman, or between the different foremen.

In addition to this there is installed a local telephone system connecting the machine, erecting, boiler and tank shops with the tool room. This system is for the tool supply service only and the location of the numerous connections throughout these shops is shown on the general tool layout and in some of the photographs. The 'phones are attached to the building columns and each has a separate line to the switchboard located in the tool room, where an attendant is stationed. The workmen are not allowed to go to the tool room to obtain tools they require, but step to the nearest 'phone and order what they wish, their orders being written down by the attendant at the switchboard. The tools are then collected by the tool room force, given to a boy, who delivers them to the man at the machine. Push carts are provided where the tools are large or a large number are required. The boy who delivers the tools takes either the check or exchanged tool back with him.

This scheme obviates the delay of waiting in line at the tool room window, which in some shops is quite serious. There is also a double check on every tool taken out of the tool room, since the order sent in by the man at the 'phone is put down in writing, delivered to the man who fills the order, and later filed for reference.

OPERATION.

Locomotives are ordered to the shop by the Mechanical Superintendent, who acts upon the reports of the various master mechanics as to the condition of the locomotive. In cases of unusual repairs, such as new frames, new cylinders, new firebox, etc., the shop is notified beforehand as to what will be required. The locomotives when ordered to the shop are accompanied by a report from the master mechanic, which shows their exact condition, and with this report at hand the work of getting out new parts that need renewing is started at once. When the locomotive arrives upon the shop tracks it is immediately inspected by the shop inspectors, who present a written report. If this shows the renewal of any part that was not shown on the first report orders are immediately issued to suit. Thus the major part of the work is well under way before the locomotive is actually brought into the shop, it being held on an outside track until ordered in and it is not ordered in until the shop is ready to actually start work upon it.

Upon arrival at the stripping pit at the west end of the erecting shop the stripping gang, consisting of a foreman and leader and 25 men, starts to work and quickly prepare it for removal from the wheels. It is then lifted off and set down upon blocks upon the stripping pit, where the strippers continue their work. Since all the locomotives coming to this shop are in for heavy repairs they are very thoroughly stripped at this point. Cylinder heads are taken off, pistons removed, valves and valve chests removed,

VIEW TAKEN FROM POINT J SHOWING PART OF THE FROG AND SWITCH SECTION OF THE BLACKSMITH SHOP. AN EQUAL SPACE ON THE OTHER SIDE OF THE TRACK IS ALSO DEVOTED TO THIS WORK. THE STANDARD TYPE OF JIB CRANE USED THROUGHOUT THE BLACKSMITH SHOP IS WELL ILLUSTRATED IN THIS PICTURE.

guides taken down, all spring rigging removed, in most cases jacket and lagging are taken off, steam and dry pipes, netting, etc., are taken out, and, in fact, practically every part that will require repairs or that would hinder the repairs of other parts, is taken off by the stripping gang.

Receptacles of various sizes and kinds, made of heavy netting, strap iron, or perforated plate, are provided for the use of the stripping gang, who place all removed parts in them for transferring to the lye vat. One of the photographs shows a view in this vicinity and illustrates a number of these baskets. The wheels and axles are wiped clean, as is also the whole stripped locomotive. After it is thoroughly cleaned the frames at the pedestals are painted a glistening white. The parts in the baskets are carried by the crane to push cars on the transverse tracks in the center of the shop, which transport them to the lye vats, where they are soaked, drained, dried and brought back into the erecting shop in their original baskets. The different parts were marked with the number of the engine upon their removal and when they are returned in a clean condition they are distributed to the proper gangs by the laborers. The foremen of the various machine gangs keep an eye upon the parts when they are removed, inspect them, and watch out for their return from the cleaning house.

The stripped locomotive is picked up by the large cranes and set down upon blocks on the side tracks in such a position that the flues can be easily removed without being interfered with by the locomotive in front. This is done by setting the locomotive at a slight angle with the track. The blocks are located underneath the cylinders and at the rear end of the frame and several blows are given to the frame at each of the pedestals with a heavy sledge, which in connection with the lifting of the locomotive by the crane invariably makes any small cracks show clearly against the white paint.

Having arrived upon the blocks the locomotive, if the frames or cylinders are not to be removed, is all ready to immediately start building up again.

The shop organization is such that the general foreman is in complete charge of the locomotive repairs and has under him an erecting shop, machine shop, boiler shop, tank shop and blacksmith shop foreman. Each of the groups of tools throughout the machine shop, which work on one particular kind of work, is presided over by a leader, who reports to the machine shop foreman. The erecting shop foreman also has assistants, who have special duties. All of these foremen and leaders meet once a week and discuss the condition of affairs as they stand at that time and report upon future work. In this meeting the schedule for the engines to go out during the following week is carefully discussed and formulated. Each man is furnished with a copy of this and understands the exact date at which the work from his gang must be delivered to the erecting floor. If for some unexpected reason he is unable to maintain his schedule he reports immediately and the locomotive is redated to suit, another engine being pushed up into its place, and all men concerned notified accordingly.

This shop was built to give heavy repairs to 45 locomotives per month. At the present time it is turning out on an average of 41 locomotives per month, and it is clearly evident that its capacity is nowhere near reached.

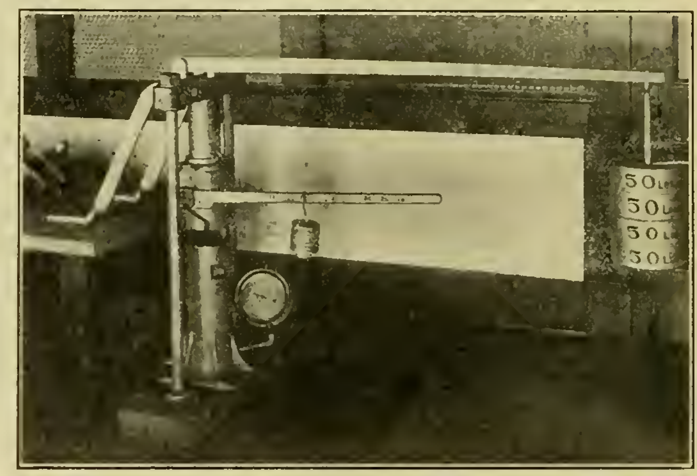
The regularity with which the locomotives leave the shop is an evidence of good mangement and hearty co-operation. A record for a recent month showed that on no working day were there no locomotives turned out of the shop and on no working day were there more than two turned out, the ones and twos alternating almost evenly. It was also very noticeable that when a locomotive leaves the shop building it is finished. On a three days visit at no time was the writer able to find any workman, outside of the breaking-in man and his fireman, engaged upon a locomotive that had left the shop.

Wages Increased.—The Pennsylvania System has voluntarily made an increase of 6 per cent. in the wages of all employees now receiving less than $300 per month.

APPRENTICESHIP.

Explaining the Principles of Leverage.

A unique method for explaining the principles of leverage has been devised at the Beech Grove shops on the Big Four Railroad of the New York Central Lines. The illustration shows a hydraulic jack arranged so that a small weight hung on the handle will lift a large weight on a beam connected to the jack head. This not only instructs the boys in the mechanical prin-



APPARATUS USED IN CONNECTION WITH LEVERAGE PROBLEMS.

ciples of leverage, but it familiarizes them with the construction and working of the jack itself. Below are some problems which are used with this work:

JACK PROBLEMS.

1. (A) With weights in position shown on blue-print, what would be the weight on jack head due to the 50-lb. weights on weight lever? (B) What would be the pressure per square inch on the ram? (C) What pressure per square inch on piston?

2. What would be the pressure on the knuckle due to the above pressure on the ram?

3. Place weights in position shown and see if they balance.

4. (A) What is the pressure per square inch on piston due to the weight shown on jack lever? (Make no allowance for friction.) (B) What weight could be lifted by jack ram due to the above weight shown on jack lever? (C) Does the weight figure out to be more or less than the weight actually lifted?

5. When the weights are in the position shown what is the ratio of the pressure on jack head to the total pressure on bottom of jack ram? This result is called the jack efficiency. In this case what is the per cent.?

6. What is the ratio of ram area to piston area?

7. What is the leverage ratio of jack lever (at the 24" mark) to the lever arm?

8. If 10 lbs. were placed at the 24" mark on jack lever, what weight could be raised by the jack ram, figuring the jack efficiency at 90%?

9. At what distance out on weight arm would it be necessary to place 150 lbs. in order to balance the 10 lbs. on the jack lever? (Prove your answer by placing the 150-lb. weight the required distance found.)

10. If 200 lbs. were placed at the 28" mark on jack lever what pressure per square inch should the gauge show, figuring the efficiency at 90%.

11. If a man weighing 150 lbs. were to apply his full weight at the 24" mark on jack lever, how many tons could he raise on jack head?

Applying Air Brakes Without Shutting Off.—It is noticeable on high speed runs that some engineers, when wishing to reduce the speed from, say, 55 to 35 miles an hour, will apply the air without shutting off. Not only does this produce more wear and tear on the brake shoes, tires and brake rigging, but it is a waste of steam and consequently coal. More time is also required to slow down.—*From a fuel engineer's notebook.*

Test of Lubricating Oils.—In a paper read before the American Society for Testing Materials, Robert Job describes a simple test of the value of lubricating oils under service conditions. He found that when heated to a temperature of 450 degrees Fahrenheit the oils which had given bad results showed a very marked darkening of color, while those which had proved satisfactory showed very little change.

BELT FACTORS.†

William W. Bird.*

The question of the proper size of a leather belt for a given power transmission resolves itself into a question of selecting various factors. These factors have been worked out by experiments, by analytical methods, and in practice. Those who are interested in the development of this work are referred to books and papers on this subject and especially to the Transactions of the American Society of Mechanical Engineers. This article will simply deal with the facts established and endeavor to put them into convenient form for use in actual practice.

The horse-power that a belt will transmit depends upon the effective tension and the belt speed. The effective tension depends upon the difference in the tensions of the two sides of the belt and on the surface friction, which depends upon the ratio of the tensions and the angle of wrap.

Experiments and practice have shown that a belt of single thickness will stand a stress of 60 lbs. per inch of width and give good results, that is it will only require an occasional taking up and will have a fairly long life. The corresponding values for double and triple belts are 105 and 150 lbs. per inch of width provided the pulleys are not too small.

Experiments have shown that on small pulleys the ratio of the tensions should not exceed 2, on medium pulleys 2.5, and on large pulleys 3. The larger the pulley, the better the contact is; the thinner the belt, the better the contact is for the same size of pulley. When the pulley diameter in feet is three times the thickness of the belt in inches, or in this proportion, we get equivalent results for different thicknesses of belts. This gives us a method of classifying our pulleys. The belt has to adjust itself in passing over a pulley due to its own thickness. Some adjustment is also necessary on account of the crowning of the pulley. These adjustments account for the different ratios for the various pulley diameters. The effects of the crown and pulley diameters are not usually considered in belt rules, which is a grave mistake. The ratios are for 180 deg. wrap and decrease with less contact.

The creep of the belt depends upon its elasticity and the load, and experiments have shown that this should not exceed 1 per cent. in good practice. In order to keep this creep below 1 per cent., it is necessary to limit the difference of tension per inch of width of single belt to 40 lbs. The corresponding values for double and triple belts are 70 and 100 lbs. per inch of width. These figures are based on an average value of 20,000 for the running modulus of elasticity of leather belting.

TABLE I.

Diameter of Pulley	Under 8″	8″–36″	Over 3 feet	Under 14″	14″–60″	Over 5 feet	Under 21″	21″–84″	Over 7 feet
Thickness of Belt	Single	Single	Single	Double	Double	Double	Triple	Triple	Triple
Factor	1100	920	830	630	520	470	440	370	330
Difference of Tensions	30	36	40	52.5	63	70	75	90	100
Per Cent. of Creep	.74	.89	.99	.74	.89	.99	.74	.89	.99
Ratio of Tensions	2.00	2.50	3.00	2.00	2.50	3.00	2.00	2.50	3.00
Tension on Tight Side	60	60	60	105	105	105	150	150	150

Table I. has been prepared on the basis of these limitations and gives a value for F in the equation

$$HP = \frac{V \times W}{F} \text{ or } W = \frac{HP \times F}{V}$$

in which HP is the horse-power, V the belt velocity in feet per minute, and W the width in inches.

TABLE II.

220°	210°	200°	190°	180°	170°	160°	150°	140°	130°	120°
980	1010	1040	1070	1100	1140	1180	1220	1270	1330	1400
810	830	860	890	920	950	990	1040	1100	1170	1240
730	750	770	800	830	860	890	930	980	1030	1100
500	570	590	610	630	650	670	700	730	760	800
460	470	480	500	520	540	570	600	630	660	700
420	430	440	450	470	490	510	530	560	590	630
390	400	410	420	440	460	480	500	520	540	560
320	330	340	350	370	390	410	430	450	470	490
290	300	310	320	330	340	360	380	400	420	440

Table II. gives corrected values for F when the arc of contact or wrap is greater or less than 180 deg. On large pulleys the creep may exceed 1 per cent. if the wrap is over 180 deg., as the increased friction gives a greater difference of tensions.

To illustrate the use of the tables, we will take the following examples:

How much horse-power will a 4 inch single belt transmit at a speed of 4,600 feet per minute passing over a 12 inch pulley? The factor is 920, therefore

$$\frac{4600 \times 4}{920} = 20 \text{ HP}$$

How wide should a belt be in order to transmit 50 horse-power at 2,000 feet per minute on 36 inch pulley?

$$W = \frac{50 \times 830}{2000} = 20.7'' \text{ single belt}$$

This gives us a width of single belt which is beyond the usual limit, 8 inches being considered good practice for the maximum width of a single belt.

$$W = \frac{50 \times 520}{2000} = 13'' \text{ double belt}$$

How wide should a single belt be in order to transmit 2 horse-power at 600 feet per minute over a 4 inch pulley with 140 deg. wrap?

In this case we take the factor 1,100 from Table I. and in Table II. find a corrected value for 1,100 under 140 deg. of 1,270.

$$W = \frac{2 \times 1270}{600} = 4.23'' \text{ single belt.}$$

How wide a belt is required for 300 horse-power at 2,000 feet per minute over 10 foot pulley?

$$W = \frac{300 \times 470}{2000} = 70.5'' \text{ double belt.}$$

This is too wide. Good practice calls for a change to triple at 48 inches unless for some special reason a narrower belt is necessary.

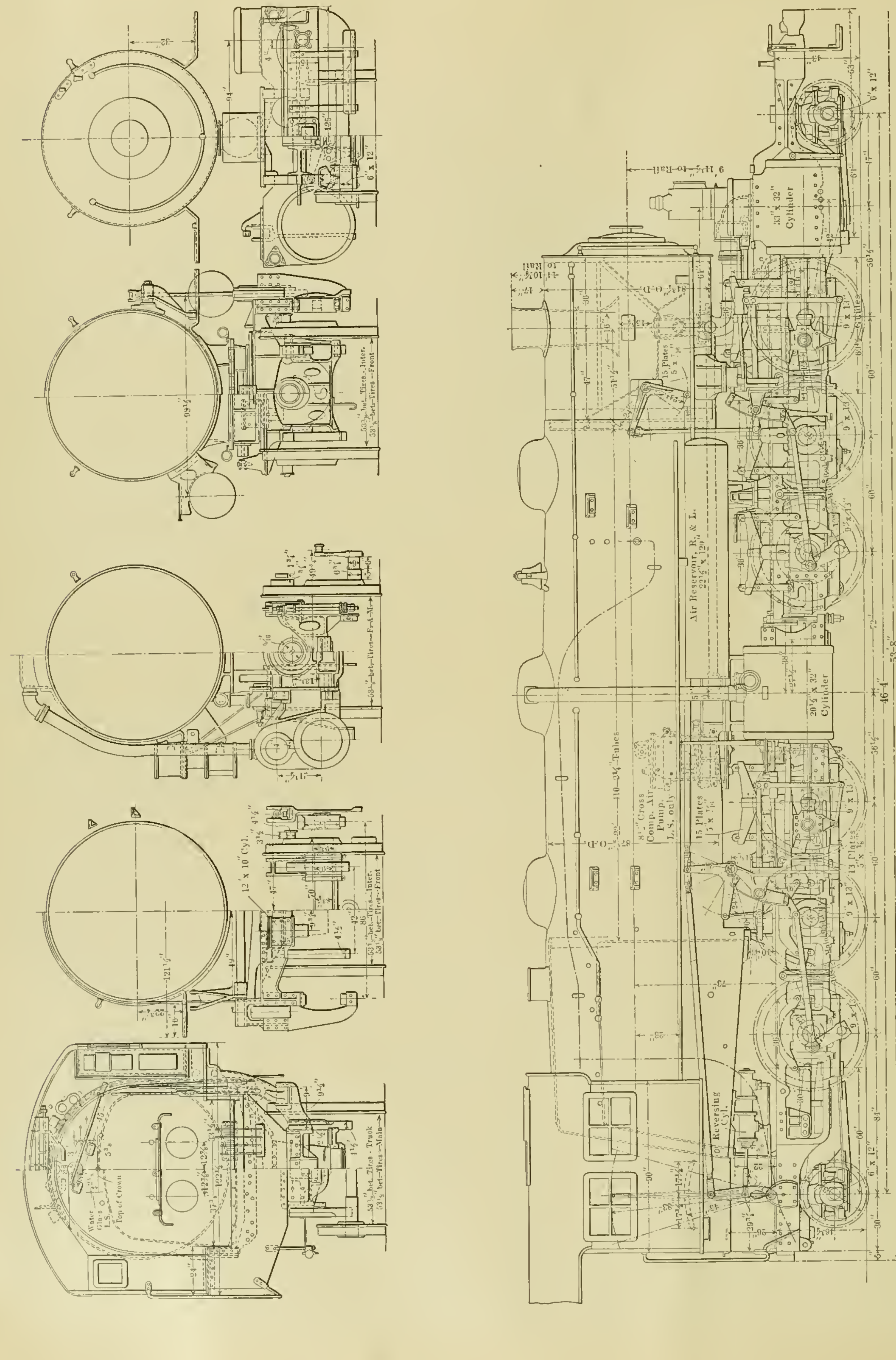
$$W = \frac{300 \times 330}{2000} = 49.5'' \text{ triple belt.}$$

The belt speed is limited by centrifugal force, but below 5,000 feet per minute the loss on this account is largely compensated for by the increase of friction due to the decrease in the time element of the contact, caused by the increased velocities.

The results given by these factors are well within working values and the belts will probably transmit 50 per cent. more power than these factors give, but at the expense of the life of the belt. A liberal allowance at the beginning means less annoyance, fewer delays in taking up the belts, longer life and less cost for renewals and repairs.

* Director of the Department of Mechanical Engineering, Worcester Polytechnic Institute.

† From the Journal of the Worcester Polytechnic Institute, Vol. XIII, No. 2, January, 1910.



GENERAL ELEVATIONS AND SECTIONS OF A MALLET ARTICULATED LOCOMOTIVE, 2-6-6-2, TYPE ON THE BOSTON AND ALBANY RAILROAD. THIS LOCOMOTIVE WEIGHS 342,000 LBS., OF WHICH 296,500 LBS., OR 87 PER CENT., IS ON DRIVERS. THE MAXIMUM TRACTIVE EFFORT (COMPOUND) IS 66,600 LBS. THE LOCOMOTIVE IS DESIGNED FOR USE IN THE BERKSHIRE HILLS SECTION OF THE ROAD.

MALLET ARTICULATED COMPOUND LOCOMOTIVE, 2-6-6-2 TYPE

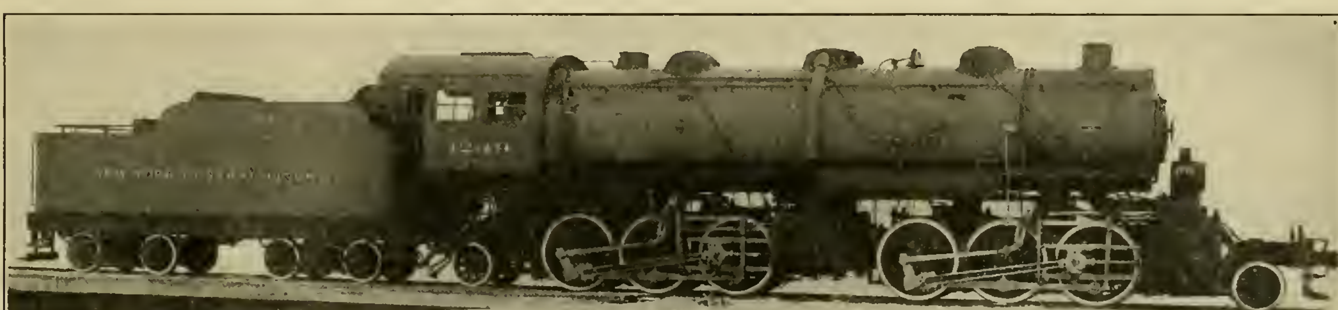
A GENERAL DESCRIPTION OF A LOCOMOTIVE WITH LARGE BOILER CAPACITY BUILT FOR FREIGHT SERVICE ON THE BERKSHIRE HILLS SECTION OF THE BOSTON & ALBANY RAILROAD.

Between Springfield, Mass., and Albany, N. Y., the Boston & Albany R. R. passes through a country where heavy grades combined with sharp curves are practically continuous. There are several long sections where grades of approximately one per cent. are encountered and eastbound, the section of six miles between Pittsfield and Hinsdale is on a grade of 1.42 per cent. Westbound a grade of 1.5 per cent. 11.5 miles long is found between Chester and Washington, Mass. Very large consolidation locomotives, aided by pushers on the two heaviest grades, have been successfully used to handle the traffic over this division for a number of years. These locomotives have a maximum tractive effort of 45,700 lbs. and a total weight of 234,000 lbs. They are practically duplicates of the design illustrated and described on page 262 of the July, 1906, issue of this journal.

Experience on other roads with Mallet compounds indicates that a decided saving in operating charges can be made over heating surface to grate area in the Mallet than has been the previous practice in locomotives of this type. Service tests of this type designed to burn bituminous coal have, however, proven that larger grate areas have hitherto been provided than were required for slow speed service. In this design, therefore, the grate area was reduced, thus facilitating firing and requiring a higher and possibly better rate of combustion.

With the exception of a larger boiler and larger truck wheels, this locomotive is practically duplicate in design to eight recently delivered by the same builders to the Denver & Rio Grande Railway. Exhaustive dynamometer and efficiency tests are now being made of this engine on the Pennsylvania Division of the New York Central.

In working order the engine has a total weight of 342,000 pounds, of which 296,500 pounds is carried on the driving wheels. The high pressure cylinders are 20½ in. in diameter by 32 in. in stroke, and the low pressure 33 in. in diameter by the same



LARGE 2-6-6-2 TYPE LOCOMOTIVE BUILT FOR THE BOSTON AND ALBANY RAILROAD BY THE AMERICAN LOCOMOTIVE COMPANY. THIS IS THE FIRST EXAMPLE OF THE MALLET TYPE TO BE PUT INTO SERVICE ON THE NEW YORK CENTRAL LINES.

a division of this character by their use and the officials of the New York Central Lines are considering the adoption of that class of locomotive for this service. The locomotive illustrated herewith was ordered from the American Locomotive Company for the purpose of determining its value in this particular case.

A comparison of the principal dimensions of the Mallet and the present standard consolidation locomotive are given in the following table:

Type.	2-8-0.	2-6-6-2.
Weight in working order	234,000 lbs.	342,000 lbs.
Weight on drivers	208,700 lbs.	296,500 lbs.
Weight on leading truck	25,300 lbs.	23,500 lbs.
Weight on trailing truck	....	22,000 lbs.
Diameter of driving wheels	63 in.	57 in.
Cylinders, diameter and stroke	23 in. x 32 in.	20½ & 33 x 32 in.
Boiler Pressure	200 lbs.	210 lbs.
Maximum tractive effort, compound	....	66,600 lbs.
Maximum tractive effort, simple	45,700 lbs.	80,800 lbs.
Driving Wheel Base (Rigid)	17 ft. 6 in.	10 ft. 0 in.
Engine Wheel Base	26 ft. 5 in.	46 ft. 4 in.
Heating Surface, tubes	3,474.8 sq. ft.	5,291 sq. ft.
Heating Surface, fire box	185.6 " "	185 " "
Heating Surface, water tubes	28.7 " "	
Heating Surface, total	3,689.1 " "	5,476 " "
Grate area	56.5 " "	56.5 " "
Average load per axle	52,175 lbs.	49,400 lbs.

From this it will be seen that the Mallet has about 45 per cent. more tractive effort than the consolidation engine, while the average weight per axle is about 2,775 pounds less, and the rigid wheel base 7 ft. 6 in. shorter. Another interesting fact evident from this comparison is that the grate area of the two classes is the same, which gives a much larger proportion of stroke. The boiler carries a working pressure of 210 pounds, and with driving wheels 57 in. in diameter, the theoretical maximum tractive power working compound is 66,600 pounds, which, with the Mellin system of compounding employed, can be increased to 80,800 pounds by working the engine simple.

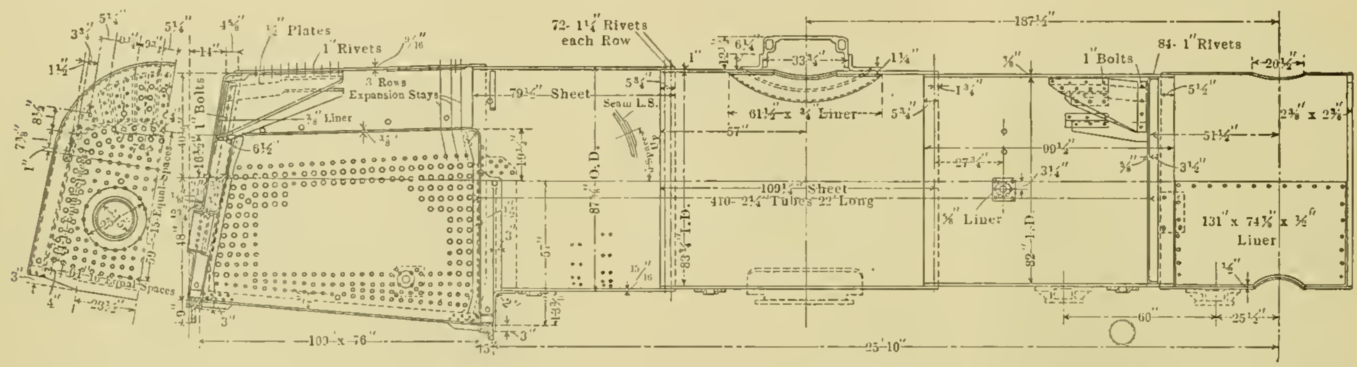
One of the most prominent features of the design is the large boiler capacity that has been provided. This is apparent from a study of the principal ratios given below. In particular the figure of 693 for the B. D. factor is below the average for even simple engines designed for a similar class of service, and would indicate that the locomotive would deliver its full theoretical tractive effort at speeds higher than most of the previous Mallets in freight service have been designed for.

A very strong and substantial system of frame bracing has been employed. In the front system the frame bracing consists of a heavy cast steel crosstie at the back end, which is bolted to both the top and bottom rails of the frame, and to which the radius arm of the articulated connection is secured. A massive vertical steel casting located between the second and rear driving wheels, extends down to the bottom rails of the frames. The upper part of this casting extends outside of the frames and furnishes a support for the self-adjusting sliding boiler bearing. Another steel casting of similar design located between the first and second pair of driving wheels constitutes the guide yoke and also the support for a second boiler bearing. In addition there is a cast steel front deck casting ahead of the cylinders which also serves for the engine truck center pin guide.

In the rear system, in addition to the cast steel foot plate at the back end, the cylinder casting and the steel casting at the front end, which includes the bearing for the center pin of the articulated connection, there is a heavy cast steel guide yoke across the upper rails of the frame between the first and second pair of driving wheels and the cast steel crosstie over the middle pedestal which furnishes the support for the front end of the firebox.

The front and rear systems are equalized together in the usual manner by vertical bolts connecting the upper rail of the front

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	66,600 lbs.
Weight in working order	342,000 lbs.
Weight on drivers	296,500 lbs.
Weight of engine and tender in working order	494,700 lbs.
Wheel base, driving	10 ft.
Wheel base, total	30 ft. 3½ in.
Wheel base, engine and tender	74 ft. 8 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.45
Total weight ÷ tractive effort	5.13
Tractive effort x diam. drivers ÷ heating surface	693.00
Total heating surface ÷ grate area	97.00
Firebox heating surface ÷ total heating surface, per cent	3.40
Weight on drivers ÷ total heating surface	54.00

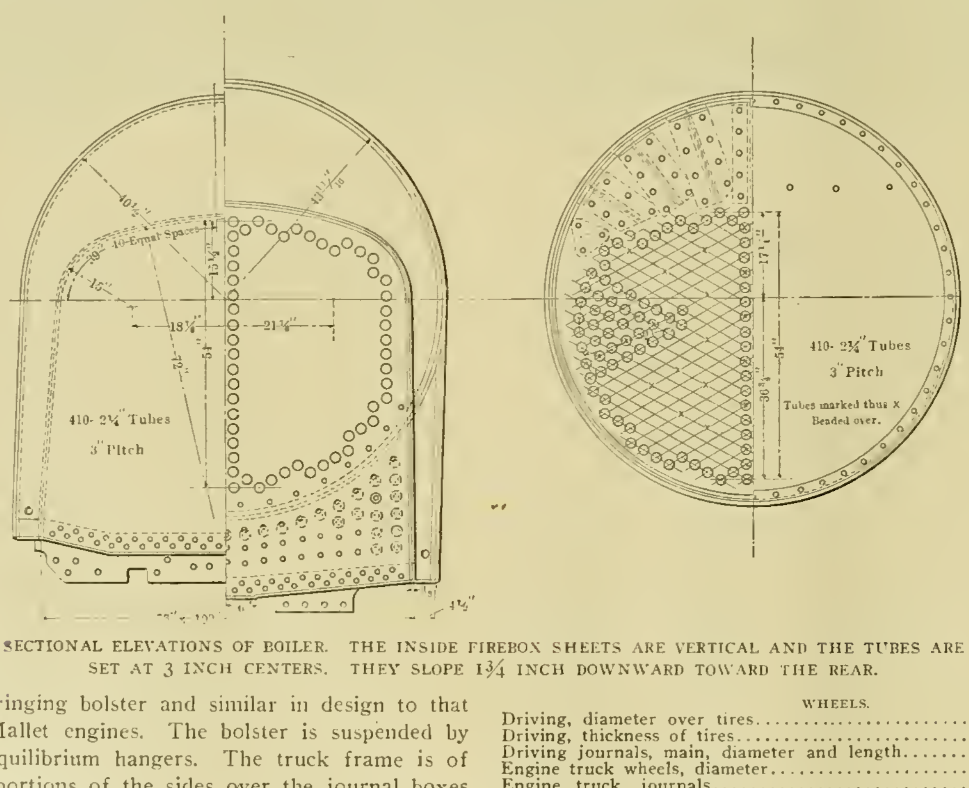


VERY LARGE BOILER ON THE BOSTON AND ALBANY 2-6-6-2 TYPE LOCOMOTIVE. THIS BOILER HAS 22 FOOT TUBES, 5,476 SQ. FT. OF HEATING SURFACE, AND 56.5 SQ. FT. GRATE AREA. THE RATIO OF HEATING SURFACE TO GRATE AREA IS 97. THIS APPROACHES THE RATIO USED WITH NARROW FIREBOX BOILERS.

frame with the lower rail of the rear frame. As in the engines of this type built by this company for the Virginian Railway, the load on these bolts is supported by a coil spring through which the lower end of the bolt passes and which press up against the bottom of the rear frame rail, thus giving the flexible support at this point which is necessary in order that the three boiler supports, viz., the two sliding bearings and the equalizing bolt, may each bear its proportion of the load in any variation of the alignment of the three.

Both the front and rear trucks are of the center bearing

Total weight ÷ total heating surface	62.00
Volume equivalent simple cylinders, cu. ft.	19.32
Total heating surface ÷ vol. cylinders	283.00
Grate area ÷ vol. cylinders	2.92
CYLINDERS.	
Kind	Compound
Diameter and stroke	20½ & 33 x 32 in.
VALVES.	
Kind H. P.	Piston
Kind L. P.	Slide
Greatest travel H. P.	6 in.
Greatest travel L. P.	6⅝ in.
Outside lap H. P.	1⅛ in.
Outside lap L. P.	1 in.
Inside lap	¼ in.
Lead	3/16 in.



SECTIONAL ELEVATIONS OF BOILER. THE INSIDE FIREBOX SHEETS ARE VERTICAL AND THE TUBES ARE SET AT 3 INCH CENTERS. THEY SLOPE 1¾ INCH DOWNWARD TOWARD THE REAR.

radial type with swinging bolster and similar in design to that of the Virginian Mallet engines. The bolster is suspended by 3-point or stable equilibrium hangers. The truck frame is of cast steel and the portions of the sides over the journal boxes are shaped to form caps for the coil springs which transmit the load to the journal boxes upon which they are directly seated.

The principal dimensions and ratios of the design are given in the following table:

WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	9 x 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	33 in.
Trailing truck, journals	6 x 12 in.
BOILER.	
Style	Straight
Working pressure	210 lbs.
Outside diameter of first ring	83¾ in
Firebox, length and width	108⅛ x 75¼ in.
Firebox plates, thickness	⅜ and ½ in.

Firebox, water space	F-5, S and B 4½ in.
Tubes, number and outside diameter	410-2¼ in.
Tubes, length	22 ft.
Heating surface, tubes	5,291 sq. ft.
Heating surface, firebox	185 sq. ft.
Heating surface, total	5,476 sq. ft.
Grate area	565 sq. ft.
Smokestack, diameter	19⅛ in.
Smokestack, height above rail	14 ft. 10⅞ in.
TENDER.	
Tank	Water Bottom
Frame	13 in. chan.
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gal.
Coal capacity	12 tons

COALING STATIONS.

To the Editor:—

Referring to the series of articles on Locomotive Terminals that appeared in your January, February and March numbers, particularly the section that considered coaling stations, I would like to make a few observations.

First, if the quantity of coal consumed by locomotives is to be accurately accounted for, the only possible solution is by weighing on scales. The question of measuring coal in a measuring pocket is a secondary question, and can only be used with any accuracy where the coal is of a uniform grade at all times, and even then, if an engine does not take an exact quantity of coal at all times, the means of obtaining accurate results are, to a certain degree, lost—*i. e.,* the man must guess at the amount.

I note in this section of the article that preference is given to the trestle type of chute where room permits, and it is stated that it has been the general custom to install this type of plant, and adds that the installation of it can be made at less expense. With the inclined type of stations, based both on a five per cent. grade, where the locomotive is used to push the cars up the incline, or a twenty per cent. incline, where the car hoist is used, we find that this station, in the first place, costs fully as much, if not more, than the mechanical types. Second, it can be designed to only coal economically one or two tracks. Third, the plants take up a great deal of room. Fourth, at the present time, or in fact since lumber has become scarce and we have been compelled to use Southern or yellow pine, the depreciation is greater than that of the housed plants, due to the fact that the inclines are long, especially the locomotive incline, and the question of maintenance is of decided importance. In the case of the five per cent. incline where a locomotive is used for pushing the cars up the incline, it is not customary to charge the time of the engine in service to the cost of handling the coal per ton, as the railway officials will usually say, "Well, we have a switch engine at that point, and this is part of its duties."

Regarding the Beacon Park plant, I wish to state that undoubtedly this trestle is the steepest of any in the country. The use of the goat at any of the incline types is very desirable, as it does away with draw-bar pull on the car direct, and also it is used to push the cars up the incline, and then can be lowered again into the pit below, and a second car is again pushed up the incline into the coaling station, and this performance can be repeated, depending upon the size of the chute and the holding capacity for the cars, viz., if the coaling station is long enough to hold three cars in length, three cars can be pushed up one after the other, and lowered away one at a time. This cannot be accomplished conveniently unless the goat is used. There have also been erected quite a number of plants of the steep incline type where scales are used successfully.

Regarding the locomotive crane for handling coal and operating the clamshell, the point at which it is to be used must be considered. This arrangement requires the services of a skilled mechanic at a higher price than is paid mechanics to operate the mechanical stations. Again, great care must be used so as not to damage the equipment, but in spite of close attention, the damage is bound to be considerable. Furthermore, the first cost of a crane is considerable, and we find by close observation that all kinds of coal cannot be successfully handled. In general, the coaling station matter is in its infancy yet, but great advancements have been made within the last six years.

The steel chain and small bucket type of plant is one that has great flexibility, and can be arranged to suit any condition. The large bucket type of stations using buckets of 1 to 2½ tons capacity give excellent service, and a great many of these are in operation.

It is not my aim to describe the different types of coaling stations, but in conclusion I would like to sum up the subject as follows: In order to get successful results, the proper type of stations must be selected to meet all the conditions under which it is to operate, and it must be understood that each plant is a distinct and separate problem. Second, the use of self-cleaning cars is a most important factor. Third, emergency storage must be considered at certain points. Fourth, the equipment must be reliable, using the best kind of machinery throughout and with ample power. At highly important stations and where the amount of coal consumed per day is very high, it is feasible to install duplicate machinery. Fifth, the question of a fireproof structure must be taken into consideration. Sixth, where frame structures of any size are erected, fire protection should be provided, and it is essential to build the power house separate from the coaling station. Seventh, the question of switching cars is an important feature. A track arrangement should be so designed so as to reduce this to a minimum, and the plant should be provided with car-pullers of sufficient capacity. Eighth, the breakage of coal must be reduced to a minimum, and this has as yet not been considered to any great extent by the railroad companies. Ninth, good labor must be employed to operate the plants, and the machinery and equipment must be looked after thoroughly, and not only this, but a proper inspection must be made of the plants at intervals to insure them receiving proper care.

This last feature is most important and we find that a great many of the coaling stations throughout the country are run absolutely without any care whatever, and we have continuously recommended that, as the coaling station question is the most important and vital, every road should be provided with the necessary talent to look after the coaling stations and see that the plants are getting the proper care, and then, without a doubt, they will get better resuls.

Chicago. R. T. Krausch.

A NEW CLUTCH PLANER DRIVE.

For reducing the wear on the belts, decreasing the power required and increasing the accuracy of the stroke of planers, a clutch drive has been designed by the American Twist Drill Company, Laconia, N. H. The general features of this clutch

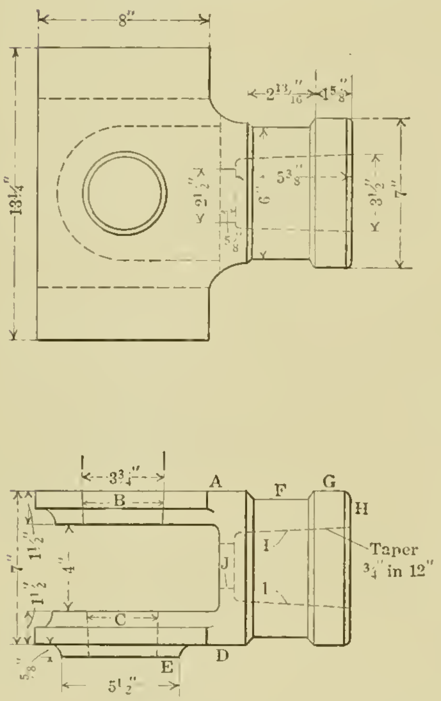
are clearly shown in the photograph, the shifting mechanism being operated by the table dogs in the usual manner. The clutch action is very positive and by its use the platen of the planer stops very close to the same point at each end of the stroke, being nearly as accurate as a shaper in this regard. It is designed for application to all standard planers.

OPERATIONS AND TIME REQUIRED FOR MACHINING CROSS HEAD ON A 36" VERTICAL TURRET LATHE.

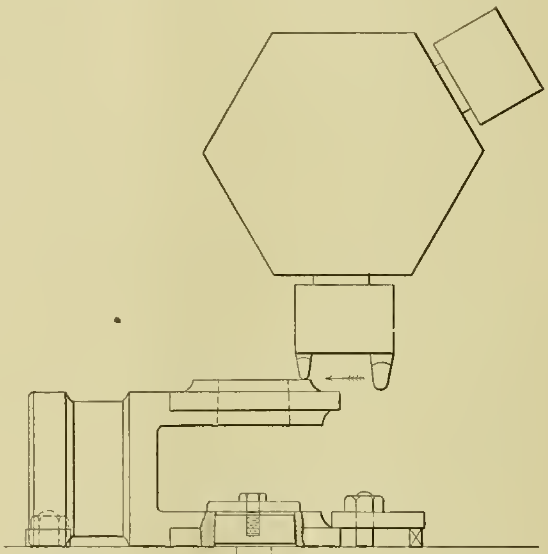
	Item.	Surface Machined.	Operations.	Depth Cut.	Feed per Rev.	Ft. per Min.	Min. each Oper.	Mins. req. Actual.
Setting No. 1	1	......	Chuck work	.....	.....	..	9	9
	2	A	Rough face A* }*	¼"	1/24"	45	15	15
	3	B & C	Rough bore B & C† }*	⅜"	1/48"	..	15	
	4	A	Finish face A }*	.....	1/12"	40	10	10
	5	B & C	Finish bore B & C }*	.....	1/24"	..	10	
	6	......	Ream	.....	Hand	25	5	5
	7	......	Unchuck	.....	.....	..	3	3
Setting No. 2	8	......	Rechuck work	.....	.....	..	5	5
	9	E & D	Rough faces E & D†	¼"	1/24"	45	13	13
	10	E & D	Finish faces E & D†	.....	1/12"	40	8	8
			Unchuck	.....	.....	..	3	3
Setting No. 3	11	......	Rechuck work	......	.....	..	9	9
	12	I	Rough bore I }*	5/16"	1/48"	..	15	
	13	J	Rough bore J }*	5/16"	1/48"	..	3	
	14	H G F	Rough turn H G F }*	¼"	1/48"	45	20	20
	15	H G F	Finish turn H G F }*	.....	1/24"	45	18	18
	16	I	Finish bore I }*	.....	1/24"	..	15	
	17	I	Extra cut I	.....	1/24"	40	9	9
	18	I	Ream	.....	Hand	..	5	5
	19	......	Unchuck	.....	.....	..	4	4
			Total time, both heads				194	
			Total actual time elapsed					136

* Simultaneous cuts.
† Two tools working in same head.

Total saving time by use of Vertical Turret Lathe, 58 min., or 42%.

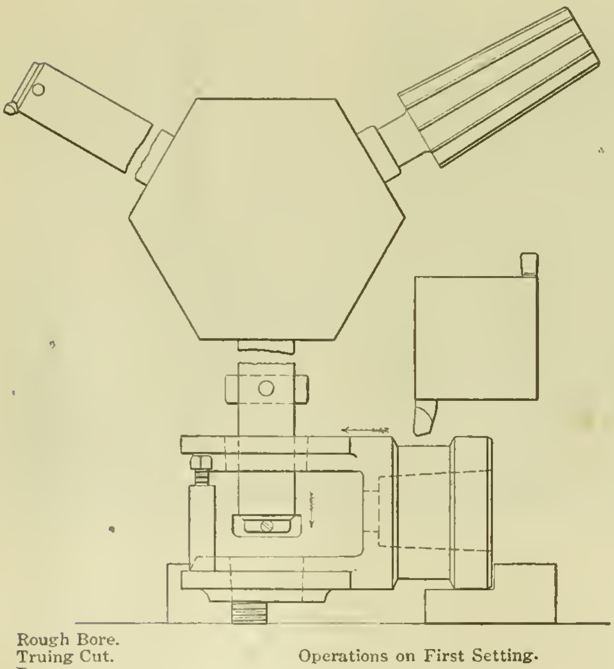


CROSS HEAD TO BE TURNED, BORED AND FACED ON VERTICAL TURRET LATHE.



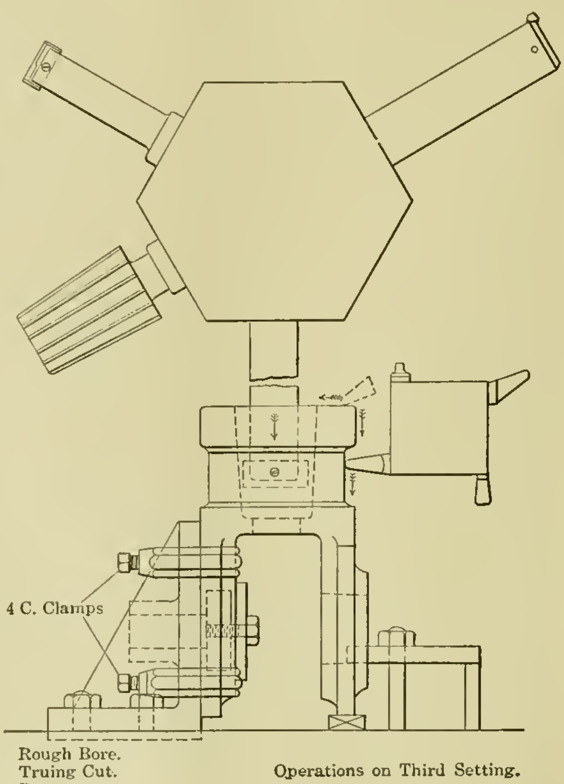
Rough Face.
Finish Face.

Operations on Second Setting



Rough Bore.
Truing Cut.
Ream.
Face. Rough & Finish.

Operations on First Setting.



Rough Bore.
Truing Cut.
Ream.
Face & Turn.

Operations on Third Setting.

MACHINING A LOCOMOTIVE CROSS HEAD ON A VERTICAL TURRET LATHE.

In the January issue, page 14, was illustrated the method of machining a locomotive piston on a vertical turret lathe, showing in detail how the work is completed in ninety minutes. The same machine is also capable of showing an equally good saving on many other classes of locomotive work, as, for example, cross heads.

The secret of the success of this machine in work of this character is, of course, the opportunity of setting all the tools required before starting operations and the ability to make simultaneously cuts, the speeds and feeds being capable of instant adjustment to suit the character of the cut.

In the present instance the cross head to be machined is shown in one of the illustrations and the work performed at each of the three seetings is also illustrated. In the table is given, in detail, the exact time required for each individual operation, the total elapsed time being 136 minutes or 2 hours and 16 minutes.

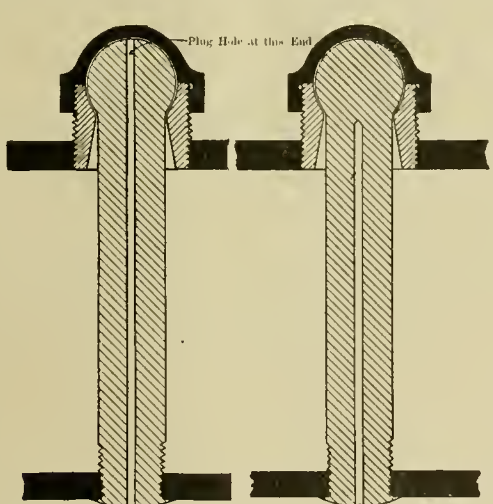
The machine for performing this work is a 36 inch vertical turret lathe manufactured by the Bullard Machine Tool Company, Bridgeport, Conn.

COMBINATION FLEXIBLE STAY WITH HOLLOW STEM.

To the Editor:—

The best method of testing flexible bolts, or how to tell when they are broken, has been a subject of considerable discussion at the last two or three Master Mechanics' and Master Boiler Makers' Conventions.

The interest of the inventors of flexible bolts to arrange a staybolt attachment at the outer sheet, which will, without straining the metal, respond freely to the expansion and contraction

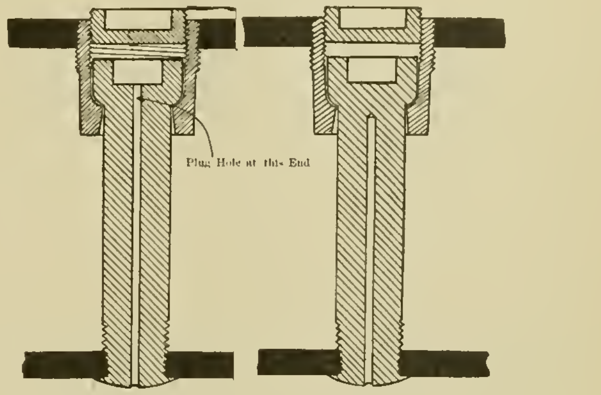


TATE FLEXIBLE STAYBOLT WITH HOLLOW STEM.

movement of the inner or fire sheet, is commendable, but we must not overlook the fact that any influence interfering with or retarding the free movement of the head will immediately convert it to the condition of a rigid stay. In other words, the vibratory strain will be thown on the metal as in the ordinary staybolt. Formation of scale or the precipitation of impurities in the water is liable at any time to interfere with the free action of the flexible head and thus bring about rigid conditions which it is desirable to avoid.

It is, therefore, quite as necessary that the flexible stay be covered by regulation staybolt inspection, the same as the solid bolt, and as a measure of safety this point should not be neglected. It is, however, impossible to detect broken flexible bolts by hammer sound, owing to the style of the flexible head attachment to the outer sheet. This leads to the necessity of removing the caps covering the heads in order to determine those actually broken. Removing and replacing those parts for the purpose of inspection means much labor and expense and is likely to cause delay to power.

To avoid this trouble I would suggest that the stems be made of hollow staybolt iron, as is shown in the illustration. Both service and laboratory tests have repeatedly demonstrated that



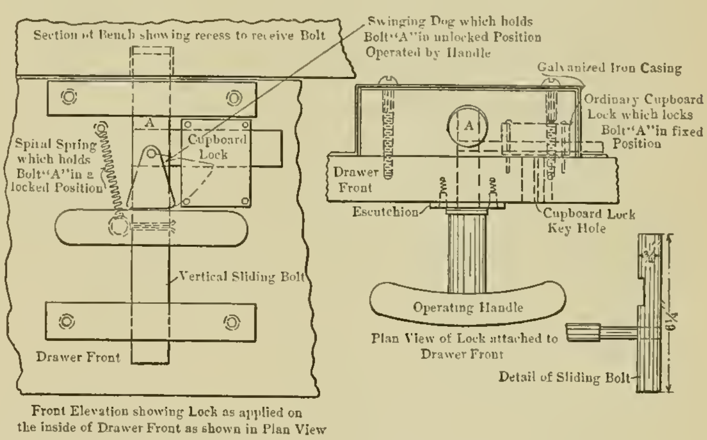
ACME FLEXIBLE STAYBOLT WITH HOLLOW STEM.

the hollow-rolled iron possesses over 50 per cent. greater endurance than solid iron, and if introduced in connection with the flexible head, it will add to the life of the stay and will in itself completely solve the question of inspection. With the use of the hollow stem a fully broken stay will not only be readily disclosed, but a fracture amounting to one-half its diameter will promptly make itself known.

John Hickey.

BENCH LOCK.

A combination handle and lock for bench drawers is shown in the illustration. The arrangement is such that a very substantial bolt secures the drawer in a closed position by the medium



of a very light and cheap lock. The arrangement and construction is clearly shown in the drawing and requires no description. These locks were applied by the contractors who built the Readville shops and have proven to be most satisfactory.

BALL PLAYERS, ATTENTION.

Leonard J. Hibbard, at the Crescent Athletic Club, Brooklyn, N. Y., chairman of the baseball committee of the Railway Supply Manufacturers' Association, will be glad to hear from any railroad or supply man who can, or thinks he can, play baseball. He has appointed Frank Martin of Jenkins Bros., New York, as captain of the eastern team, and Jack Ristine, of the Union Draft Gear Company, of Chicago, as captain of the western team.

Idle Cars.—On March 16 there was a shortage of 27,187 cars of all classes and a surplus of 44,529. This is about the same ratio that has existed for three months.

[Established 1832]

THE OLDEST RAILROAD JOURNAL IN THE WORLD

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

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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

When a Subscriber Changes his address *he should notify this office at once, so that the paper may be sent to the proper destination.*

CONTENTS

LOCOMOTIVE SHOP DESIGN.

Considerable space in this issue is devoted to a description of the locomotive shop of the New York, New Haven & Hartford Railroad, located at Readville, Mass. This shop is designed and used for heavy repairs only and has now been in operation for about three years; a sufficient time to develop any errors of judgment in either the design of the buildings or arrangement of the tools. As a matter of fact, the original arrangement has hardly been changed at all, and nothing but praise is heard in connection with the whole design. The natural lighting of the shop, by means of transverse monitors with skylights, is remarkably satisfactory. The cement floor has proven to be excellent and the original selection and location of the machine tools has, with a few minor exceptions, proven to be well suited to the work the shop has to perform. One feature of the design that is unusual and is particularly convenient, is the placing of raised concrete platforms along one side of the building, these being of a height which brings them level with the floor of a push cart.

Another unusual and very useful equipment in this shop is the tool room telephone service, whereby it is unnecessary for any machinist or boiler maker to leave his work in order to get the tools he desires. This arrangement permits a man to anticipate his needs and to have a tool at hand when he is ready to use it. Taken collectively, the time saved in a big shop by this system is very large.

RAILROADS AND THE MACHINE TOOL INDUSTRY.

Comment is often made on the continually increasing size of locomotives and cars and we hear much of the difficulty of enlarging terminal facilities fast enough to take care of the increased traffic which this larger equipment handles. As a matter of fact, although it is seldom mentioned, there is practically as much necessity for increasing and improving the machine tool equipment of the shops that are to take care of the repairs of these larger locomotives and cars as there is in providing more trackage in the yards. It has been found possible in many cases to install new machine tool equipment in an old shop and satisfactorily provide for the much heavier repair work without erecting a complete new plant. Most of the present machine shops are in no ways equipped to handle the repairs on the locomotives that the roads are now purchasing and an estimate of the machine tool equipment that it will be absolutely necessary to purchase within the next two or three years would be astonishing if it were possible to even arrive at approximate figures.

WANT POSITIONS—MEN WANTED.

During the past few months we have had an unusually large number of requests to recommend candidates for various positions on railroads and in supply companies. While we do not wish to assume the position of a regular employment bureau, we are, of course, glad to be of all possible assistance to our subscribers and advertisers.

We have, therefore, decided to devote a space in our editorial section, which is not to exceed one column per issue, for the publishing of information of this kind. The "want position" section will be open only to our subscribers, who will be permitted not over three insertions per year. The "men wanted" section will be open to any one who wishes to avail himself of the opportunity. There will be no charge made for this service.

CORRECTION.

Through an accident in the press room, the name of the author of the article appearing on page 105 of the March issue, entitled "Methods of Supervising Material Compared With Methods of Supervising Labor," was omitted. This article was written and furnished us by Mr. Clive Hastings.

THE DRAFT GEAR SITUATION.

By Kenton Adams.

[EDITOR'S NOTE.—AT OUR REQUEST THE AUTHOR OF THIS ARTICLE HAS GIVEN HIS IDEAS ON THE DRAFT GEAR SITUATION. WHILE WE ARE NOT PREPARED TO ENTIRELY AGREE WITH ALL OF THE OPINIONS EXPRESSED, OR TO BELIEVE THAT CONDITIONS ARE ACTUALLY AS SERIOUS AS HE INDICATES, WE DO BELIEVE THAT A FRANK DISCUSSION OF AFFAIRS AS THEY EXIST WILL DO NO HARM. THEREFORE WE WILL BE VERY GLAD TO RECEIVE OTHER EXPRESSIONS OF OPINION FROM BOTH RAILWAY MEN AND MANUFACTURERS WHO ARE IN A POSITION TO SPEAK FROM PERSONAL EXPERIENCE, AND WILL PUBLISH AS MANY OF SUCH LETTERS AS POSSIBLE IN SUCCEEDING ISSUES. IF YOU KNOW ANYTHING ABOUT DRAFT GEARS LET US HEAR FROM YOU.]

You ask me to give my ideas on the draft gear situation. While possibly I am not as well fitted to speak on this subject as some others, still I have given it considerable study and have had a far amount of experience with draft gears. Taking everything into consideration the situation appears to me to be serious, in some cases even very serious. As I look back I do not remember a time when there has not been more or less trouble with draft gears. Much progress has, of course, been made in the design and construction, attachment and location of draft gears during the past ten years, but requirements seem to have increased as fast, if not faster, than the improvements, so much so that it seems as if now, in spite of all the money and talent that have been given to a study of the subject, the elaborate tests that have been made, and all the investigations and reports of able committees, the situation is in nearly as bad shape as it ever has been.

This may seem to some to be pessimistic; if it does, let them take a trip through a large car repair yard and see if they can find anythng about draft gears to make them optimistic. Let them see how many bent and broken striking plates and crushed end sills are to be found that will indicate very forcibly how badly the capacity of the gears have been exceeded in service. Let them look at the broken knuckles, the sheared rivets in the sills and coupler shanks, to say nothing of the broken gears themselves. I do not believe that such an investigation will impress any one as reflecting a satisfactory draft gear situation, or indicate that the draft gear problem has been solved. You may say, "but the draft gears are misused," certainly they are, but where is the man to be found that can stop this misuse and keep his yards reasonably cleared. Misuse is not an excuse. The gears must be made to stand the service as it exists, and all the blame cannot be laid to the yard crews, either.

Consider further the expense resulting from this one trouble: the claims resulting from an occasional wreck; the delay on the road due to break-in-twos; the cars out of service; the transferring of loads, as well as the repairs themselves. These represent a very respectable sum, even in comparison with such things as the coal bill and the cost of operating trains. It is these things that lead me to say that the situation is serious.

Has everyhing been done that can be done? By no means. On this point I am optimistic. The problem will be solved eventually, no doubt; just how it will be done I am unable to say. There are new designs of draft gears being brought out all the time, some of which seem to have excellent possibilities. Every practical road test made shows up some weak features and some strong ones in the different designs. There will be testing machines built that will reproduce actual service accurately enough to give data which will hasten the determination of the good features and the discarding of the weak ones in the designs tested, so that by a process of elimination no doubt the proper combination will be eventually secured. Possibly several arrangements of different principles will prove themselves capable.

From present appearances it looks as if a combination of spring and friction surfaces would be the basis of the final solution. In fact it seems to be pretty generally admitted that one of the principle functions of the draft gear under modern conditions is to absorb and dissipate the energy of the pull or push that is greater than, say, 50,000 lbs. Friction seems to be the most practical way of doing this, although there are, of course, other means of dissipating energy that may finally be adapted to this use. Below 50,000 lbs. springs are in every way satisfactory. They cushion the constantly recurring shocks that would soon rack a car all to pieces. They yield quickly and with an increasing resistance which permits the locomotive to start a long train with ease, and if it was not for the fact that a spring is unable to absorb and dissipate energy the problem would be solved without any further investigations. But when it comes to a point where blows of several hundred thousand pounds are delivered to a gear, springs alone are out of their class, not because they are unable to stand it, but because the car and coupler are unable to stand the recoil.

Therefore I believe that some type of spring will be used for what can be called ordinary use and that this will be supplemented by an arrangement which will absorb and dissipate blows that are out of the ordinary. This seems simple enough, and there are a number of gears at present in more or less extensive use that are designed to do exactly this. The only difficulty is that they are not doing it successfully, at least in all cases. Some of them were entirely successful at the time they were first designed, but they have been unable to stand up to the continually increasing requirements.

I don't wish to be understood as saying that there are no successful draft gears now in service, but simply to state that, in my humble opinion, there are no draft gears now in extensive use that are successful under all conditions of service, *i. e.*, I have been unable to find a gear that I am willing to point to and state "this is perfection; we need look no further."

INCREASING THE EFFICIENCY OF WORKMEN.

To summarize: If you keep an exact record of what each worker does, surround the men with conditions under which they can work at high efficiency, and compensate the efficient one liberally, no man will spend his spare time in trying to find out how to raise the wages of the other fellow. Workmen, as a rule, will do more work if their earnings are increased by so doing, and you will find great difficulty in getting the efficient ones into labor unions if they are not benefitted by joining.

The point that seems very clear is that the employer is quite as much responsible for the labor unions as the men are themselves, and that he can never expect to adjust his difficulties with the employees until he furnishes them with a means of accomplishing their ends (namely, bettering their condition and getting more money) which will appeal to them as being better than the means that they are now using; for, as was said before, so long as he conforms to the laws of the State, the workman has a right to govern his actions in the manner that will best subserve his interests. As we cannot make him do anything else, we must convince him first that what we offer is better than what he already has. When he is convinced, the problem is solved.—*H. L. Gantt in The Engineering Magazine.*

FOR THE SHOP SUPERINTENDENT AND FOREMAN

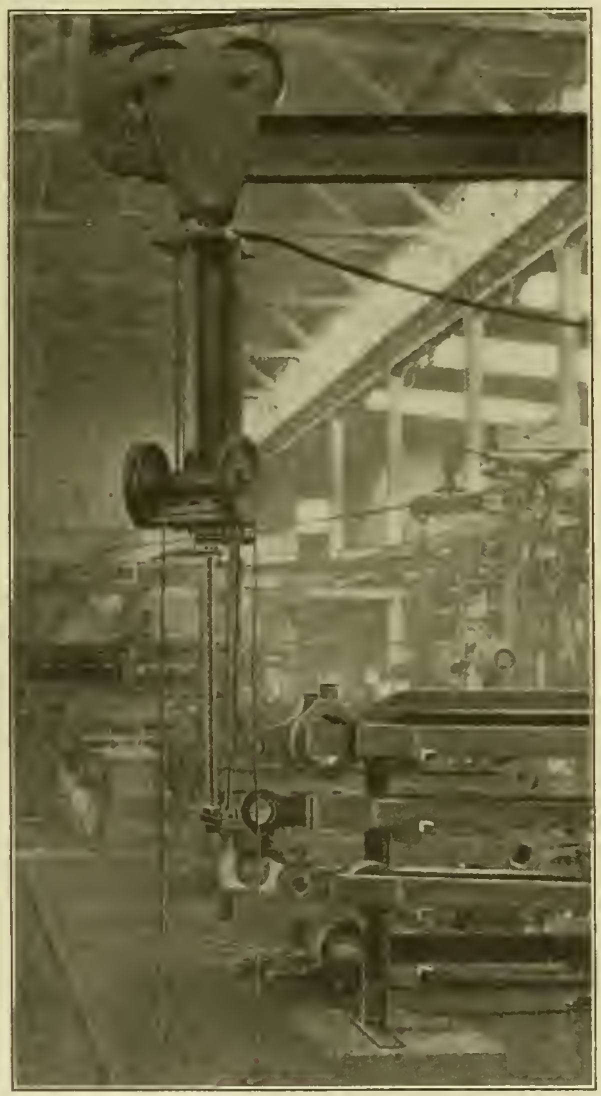
[EDITOR'S NOTE.—THE FOLLOWING JIGS AND HOME-MADE DEVICES HAVE BEEN COLLECTED VERY LARGELY FROM THE READVILLE LOCOMOTIVE SHOP OF THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD AND THE WEST SPRINGFIELD SHOP OF THE BOSTON & ALBANY RAILROAD. OTHER SHOPS CAN MAKE NEARLY, IF NOT QUITE AS GOOD, A SHOWING, AND WE WILL BE GLAD TO OBTAIN AS MUCH MATERIAL OF THIS KIND THAT HAS NOT PREVIOUSLY BEEN PUBLISHED AS POSSIBLE. WE ARE GLAD TO PAY LIBERALLY FOR ARTICLES FURNISHED US EXCLUSIVELY THAT ARE ACCEPTED FOR PUBLICATION.]

PNEUMATIC HOIST WITH INCREASED LIFT.

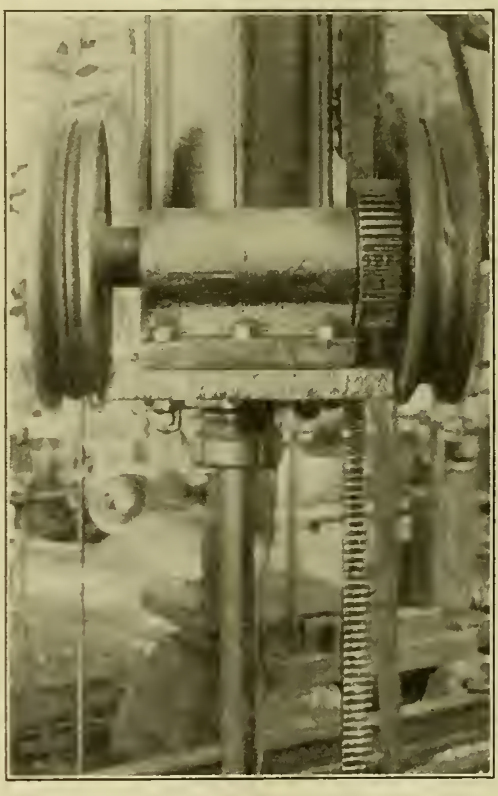
The great disadvantage of an air hoist consisting simply of a supported cylinder is that in lifting heavy weights it raises them rapidly and with a jerk, it being practically impossible to gauge the height of lift with any accuracy and also when lowering, the rods or other parts that are being handled are practically given a free drop. In spite of this, however, the air cylinder hoist is very commonly used because of its cheapness and simple arrangement.

To avoid these difficulties an arrangement has been applied to the air cylinder used in the rod gang at the West Springfield shops which not only permits it to give a positive lift that can be accurately adjusted, but also increases the height of the lift as compared to the stroke of the cylinder.

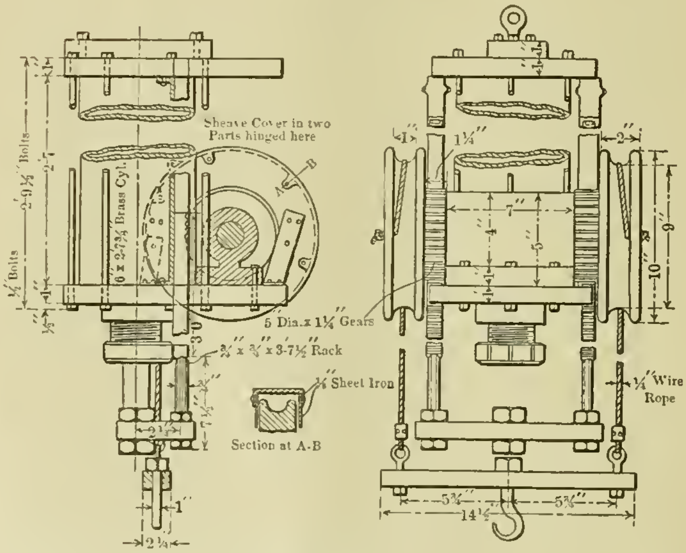
As will be seen in the illustrations, this arrangement consists



AN AIR HOIST WITH LONG LIFT AND POSITIVE ACTION. THE AIR PISTON OPERATES A RACK WHICH MESHES WITH GEARS ON THE SHAFT ABOVE TO WHICH THE CABLE PULLEYS ARE KEYED. THE EXAMPLE SHOWN HAS BUT ONE RACK. A LATER DESIGN EMPLOYS A DOUBLE RACK. IT IS USED IN THE ROD GANG OF THE WEST SPRINGFIELD SHOPS.



A CLOSE VIEW OF THE AIR HOIST SHOWING THE RACK AND GEAR.



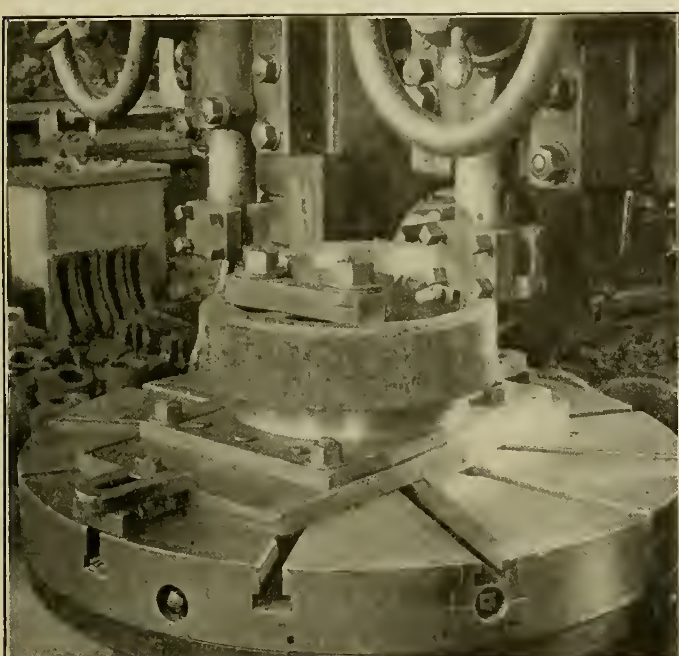
DETAIL SHOWING CONSTRUCTION OF PNEUMATIC HOIST WITH INCREASED LIFT.

simply of a cross bar at the end of the piston rod to which are connected two racks that are guided in a frame at the bottom of the cylinder and mesh with the gears on a shaft, to which two sheaves are keyed, the shaft being carried in bearings that are secured to an extension of the plate forming the lower cylinder head. The two sheaves carry cables which are connected at the lower end to the cross bar with a hook in its center.

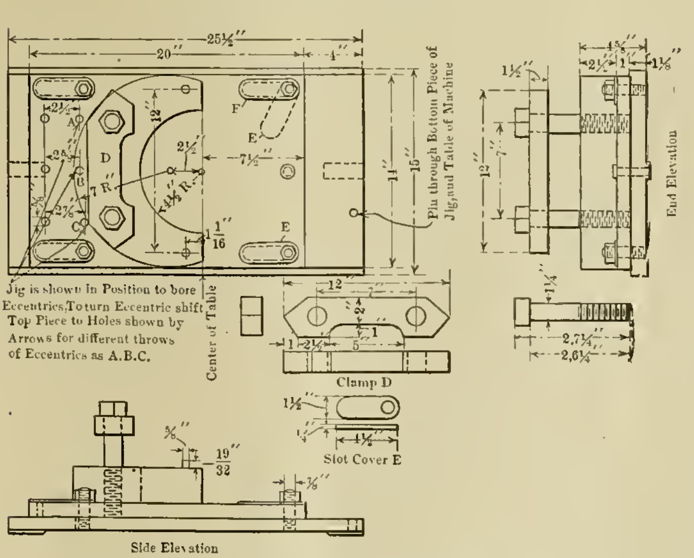
It is evident that the size of the sheaves can be adjusted so as to give any lift desired within the lifting capacity of the cylinder, the greater the lift the smaller the capacity and also that the racks and gears form a friction brake which largely eliminates the rebound when raising or lowering.

BORING AND TURNING ECCENTRICS.

A jig which permits the accurate boring and turning of an eccentric on a boring mill without re-setting, is shown in the accompanying illustrations. It consists of a plate clamped and pinned to the table of a boring mill, upon which is seated a second plate having a crescent shaped raised part for holding the eccentric. This upper plate fits between raised bosses on the lower and the bolts connecting them together pass through slotted openings in it.



VIEW SHOWING THE ECCENTRIC BORING AND TURNING JIG ON A BULLARD BORING MILL. AFTER THE ECCENTRIC IS BORED THE UPPER PLATE IS SLIPPED ALONG THE BASE A DISTANCE EQUAL TO THE THROW AND THE TURNING CAN START WITHOUT FURTHER ADJUSTMENT.



DETAIL OF CHUCK FOR BORING AND TURNING ECCENTRICS.

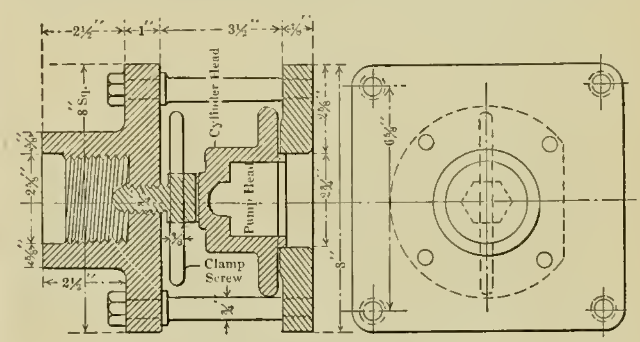
The eccentric is clamped on top of the raised section of the upper plate and either bored or turned as desired. That operation being completed, the bolts are loosened and a ⅝ in. pin which passes through both plates, is raised, permitting the upper plate to slide a distance equal to the throw of the eccentric, when the pin is again inserted, there being holes drilled to suit the different sizes. It can then be completed without further adjustment.

It is claimed at the Readville shops, where this device was gotten up, that it gives a saving of 50 per cent. over the old method of doing work.

BORING LEFT MAIN VALVE CYLINDER HEAD, WESTINGHOUSE AIR PUMP.

The difficulty of holding the left main valve cylinder head for boring has developed a chuck, which is fitted to the spindle of a lathe, that performs this service most satisfactorily at the Readville shops.

This chuck consists of a face plate secured to the lathe spin-



JIG FOR BORING LEFT MAIN VALVE CYLINDER HEAD—WESTINGHOUSE AIR PUMP.

dle, from which is supported by four bolts a plate having an opening of the proper diameter to take the lip of the cylinder head. In the center of the face plate is a screw clamp which sets against the top of the head and holds it securely in position. A lug that fits against the flat side prevents it from turning.

USING OLD BOILER LAGGING.

Most railroads make their own lagging for locomotives that have gone through the shop. This in some cases consists of a mixture of lime and asbestos softened with water. It has been the usual custom to throw away the lagging removed from the boiler when it comes in and to supply new lagging complete as it goes out.

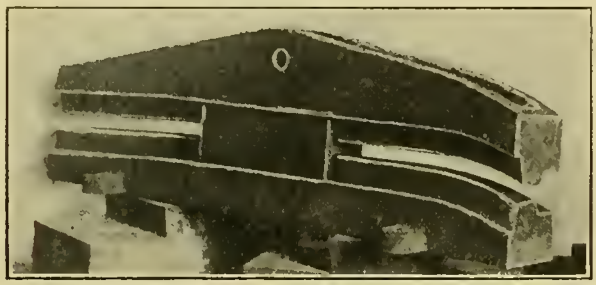
At the Collinwood shops it has been the practice for three or four years to grind up the lagging taken from a locomotive and by mixing with a small amount of new material it is suitable for application to engines going out. This is done by collecting the old lagging at one point in the shop where a rattler, the surface of which consists of small slats with narrow spaces between them, is installed in a large box. The old lagging is put into the rattler and several pieces of bar iron with round corners are thrown in and the machine is started. As the lagging becomes pulverized it drops through the spaces between the slats and is then shoveled out, there being a door at the bottom of the box for this purpose, and taken to the vat where it is mixed with water and is then ready for use.

Analysis of costs, under the old and new methods, show that where it previously cost $23 for material and labor to lag a large locomotive, the cost at the present time is less than $8, leaving a saving of over $15 per locomotive. It is found that about 70 per cent. of the lagging can be saved and used over in this manner, which is not only a matter of economy in the saving of the material, but also prevents it littering up the shop and eliminates the trouble of carrying it to the scrap bins and scrap cars.

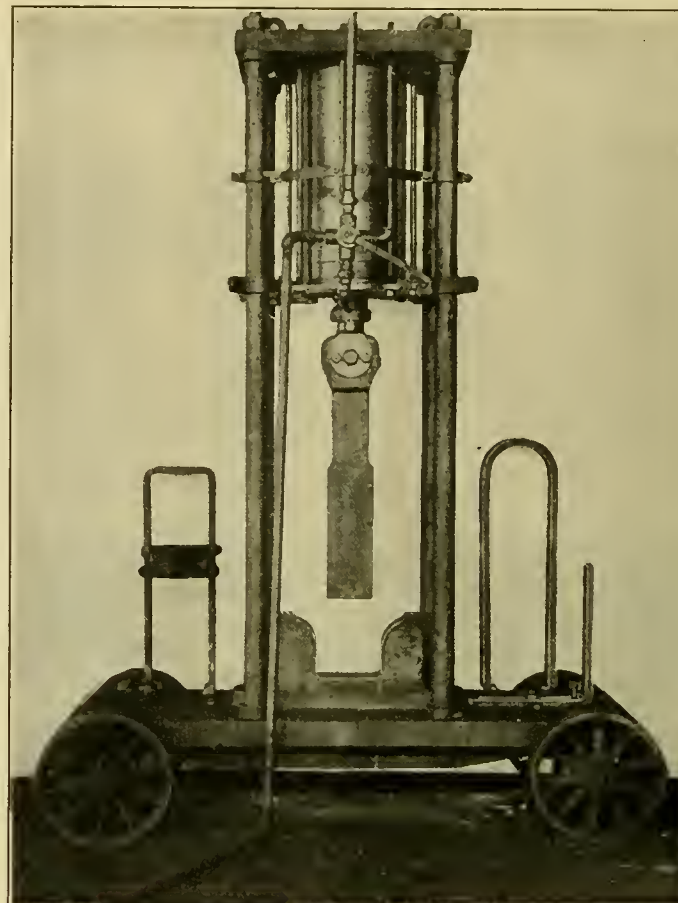
PNEUMATIC FORGING MACHINE.

Forming guard rails by hand is a very tedious, as well as expensive, process, and in blacksmith shops which are crowded with work, an order for 50 or more guard rails is not received with pleasure.

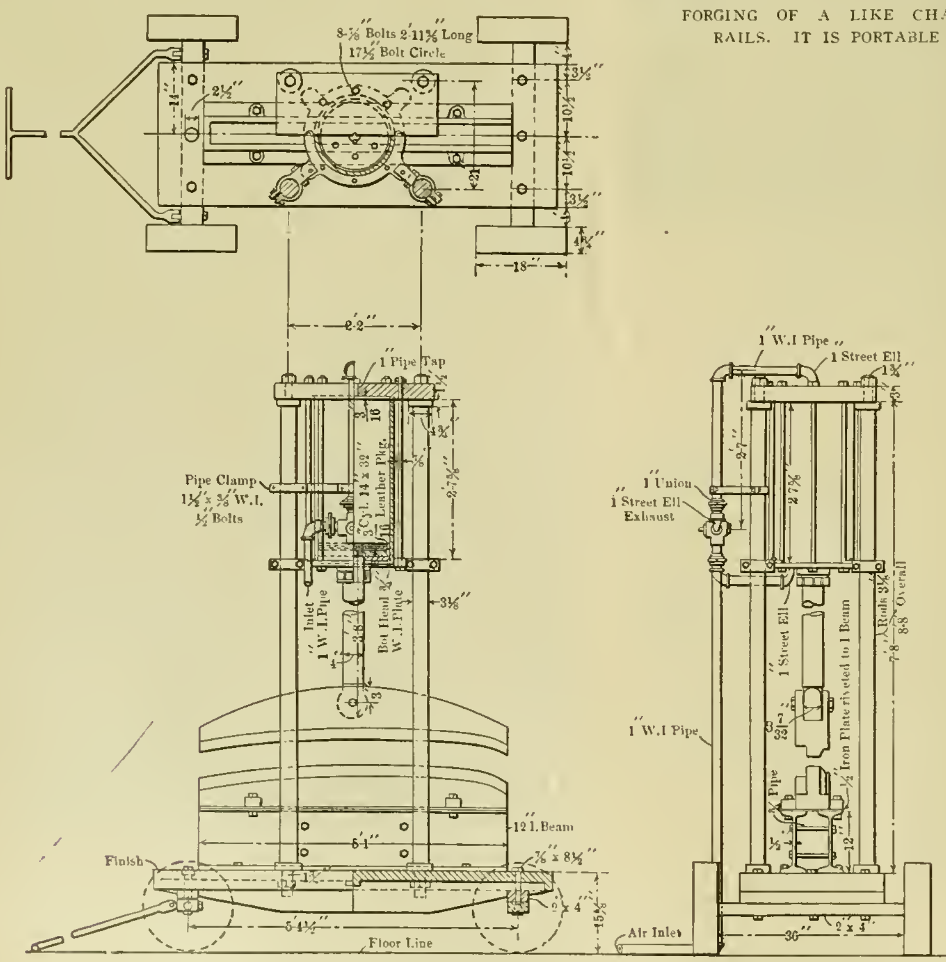
This difficulty at the West Springfield shops has been overcome by the use of a pneumatic forging machine, which was designed and built at the shops. It consists of a heavy cast iron bed plate, mounted on a truck, supporting four 3¼ in. hollow columns, which in turn support a 14 inch air cylinder having a stroke of about 30 in. Upon the piston rod and on the bed plate



DIES FOR FORMING GUARD RAILS UNDER A PNEUMATIC FORGING MACHINE. BOTH BENDS IN ONE END OF THE RAIL ARE MADE IN ONE OPERATION.



PNEUMATIC FORGING MACHINE EQUIPPED WITH DIES FOR FORGING DRAFT GEAR YOKES. THIS MACHINE ALSO DOES OTHER HEAVY FORGING OF A LIKE CHARACTER, INCLUDING GUARD RAILS. IT IS PORTABLE AND OF LARGE CAPACITY.



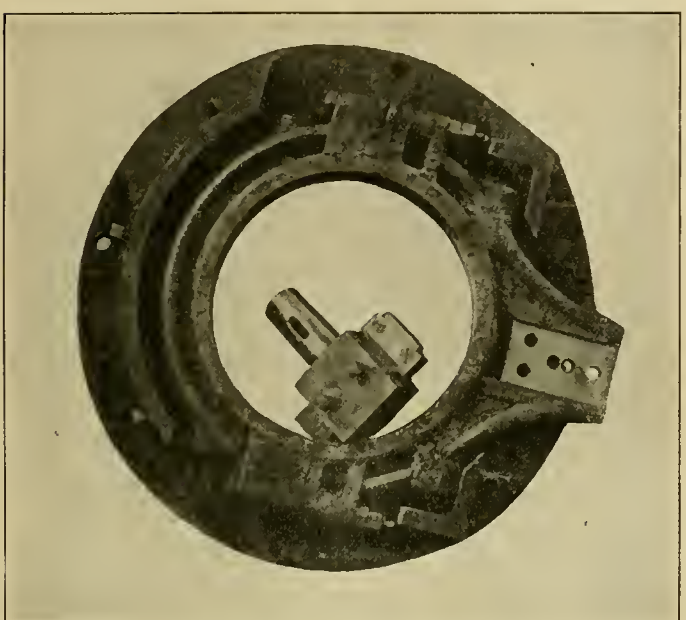
VERTICAL PNEUMATIC FORGING MACHINE FITTED WITH FORMERS FOR MAKING GUARD RAILS.

are mounted the dies. Not only are guard rails formed in this manner with great ease and rapidity, but heavy coupler yokes and other similar forgings are also being made. The machine can be moved anywhere around the shop, as needed, and has proven to be a most profitable device.

There is air admission both at the top and bottom of the cylinder, with a four-way valve on the air line so arranged that when air is being admitted to either side of the piston it is being exhausted from the opposite side. The construction and arrangement of the machine are clearly evident from the illustration.

BORING MILL CHUCK FOR ECCENTRIC STRAPS.

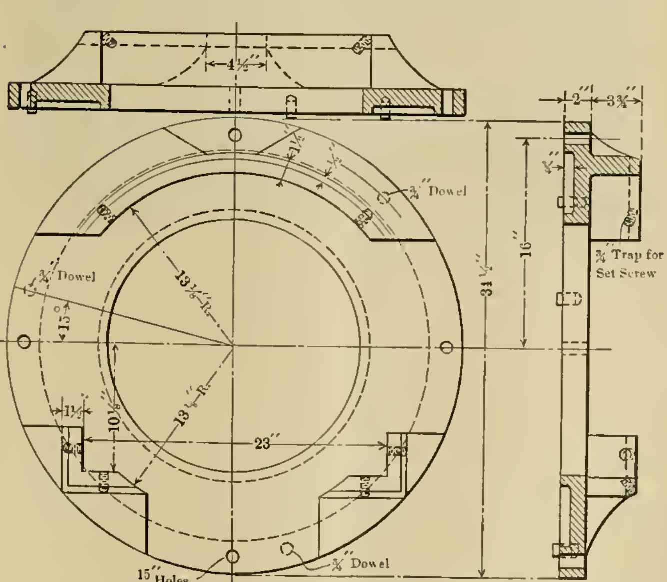
Because of their irregular shape the chucking of an eccentric strap on a boring mill table is usually a matter of some difficulty and requires considerable time. When there are a dozen



ECCENTRIC STRAP BORING JIG AND FORMING TOOL. THIS JIG ON A BORING MILL AFTER BEING ADJUSTED TO ONE SIZE OF STRAP REQUIRES ONLY THE SLACKING OFF AND TIGHTENING OF TWO SET SCREWS TO PROPERLY SET OTHERS OF THE SAME SIZE.

or so to be finished, each of them requires nearly the same effort and the total cost of time during which the machine is not in operation is all out of proportion to the value of the work done.

A special chuck or jig which largely obviates this difficulty



DETAIL OF CHUCK FOR TURNING ECCENTRIC STRAPS.

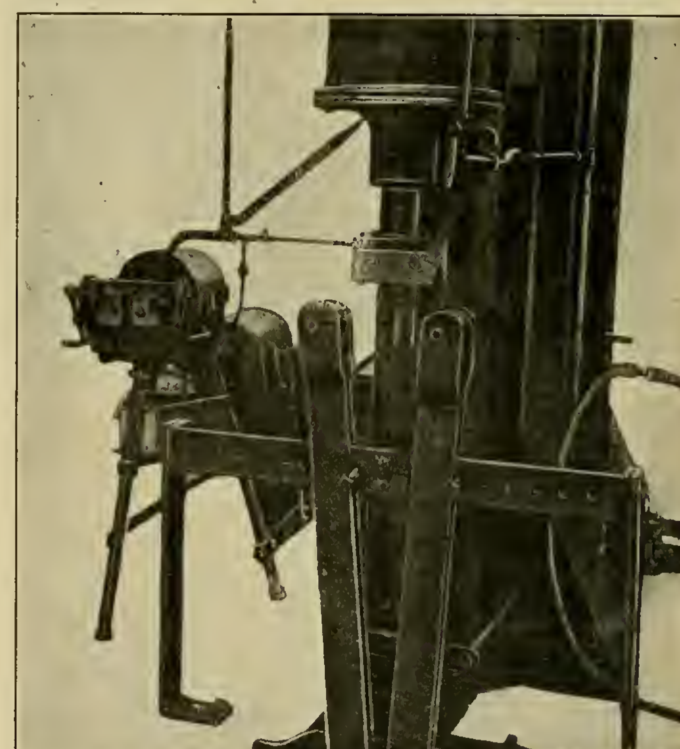
and has made it possible to reduce the piece work price on this job by 56 per cent. has been designed and is in use at the West Springfield shops. The illustration shows its form and the method of securing the strap in it. The base is turned circular and the chuck is first approximately centered on the bed of a boring mill. A strap is then put in and accurately centered and secured by the set screws. When it is to be removed the set screws on one side only are released and the next strap can be put in and tightened without further calipering.

On new work a roughing cut is first taken and then the finishing tool shown in the center is run in and cleans up the cut, bringing it to the required diameter. On repair work the finishing tool only is usually required.

Different sized chucks are provided for the various classes of straps.

SIMPLE PIPE BENDER.

On one of the columns between the machine and erecting shop at Readville is secured a 14 inch air brake cylinder on the piston of which is a block secured to a simple cross head sliding on a guide secured to the post just back of it. Below this cylinder are two arms pivoted at the floor, the top of which are forked



VIEW SHOWING A HOME MADE PIPE BENDING MACHINE. THE ARMS HINGED BELOW CAN BE SWUNG APART SO AS TO GET PRACTICALLY ANY RADIUS BEND REQUIRED. THE MACHINE AT THE LEFT IS AN AIR OPERATED PIPE THREADER, WHICH IS LUBRICATED BY A HOME MADE SIPHON OPERATED BY AIR.

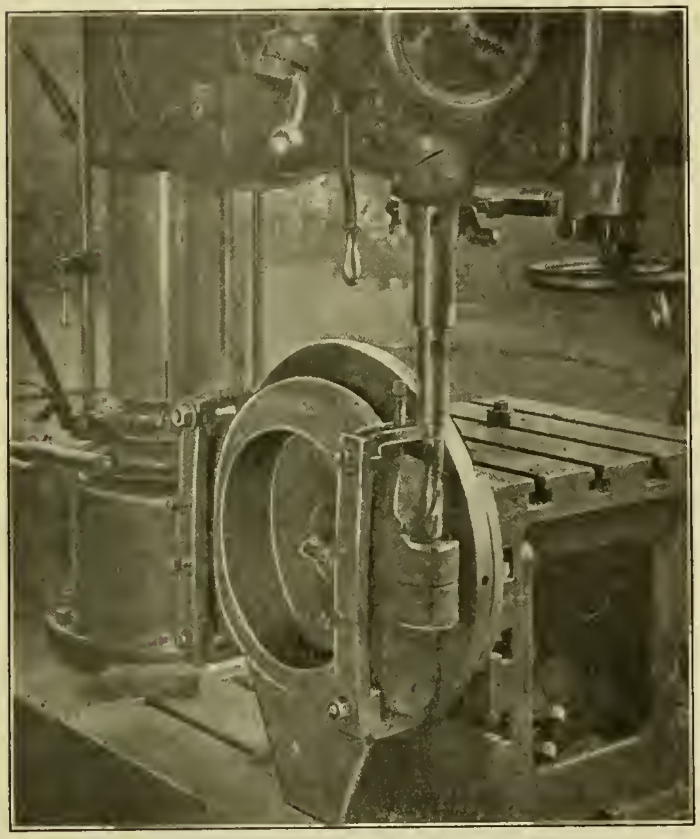
and carry rollers. These arms are held in any desired position by pins in a frame that passes through them.

In bending a pipe any desired radius can be obtained by swinging the arms apart or together. They are quickly adjusted and the cylinder is of sufficient size to bend all pipes required on a locomotive. A gauge is mounted on top of the cylinder and a locomotive equalizing reservoir is fitted in the air line leading to it.

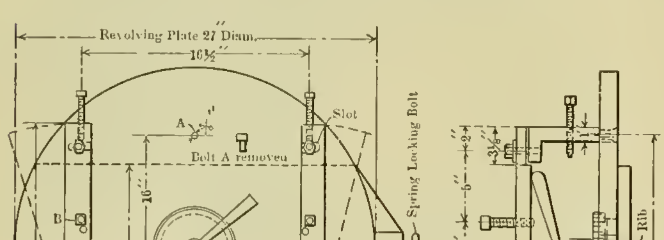
Alongside of this pipe bender is a pipe threading machine, mounted on a simple tripod of pipe and fittings, which is driven through gearing from an air motor. Underneath the threader is a shelf that carries a specially shaped pan, into which the lubricant drains after passing through a sieve. An air siphon arrangement draws it out of the pan and circulates it over the cutters again.

DRILLING AND TAPPING ECCENTRIC STRAPS.

On the eccentric straps used on the New York, New Haven & Hartford Railroad there are 18 operations of drilling and tapping, not including the holes for the eccentric rod. This work formerly required nine settings of a new strap and required two hours for its completion.



ECCENTRIC STRAP DRILLING JIG. THE PLATE HOLDING THE STRAP CAN BE REVOLVED SO THAT ALL OF THE DRILLING AND TAPPING, EXCEPT FOR THE ECCENTRIC ROD, CAN BE DONE WITHOUT REMOVING THE STRAP FROM THE JIG.

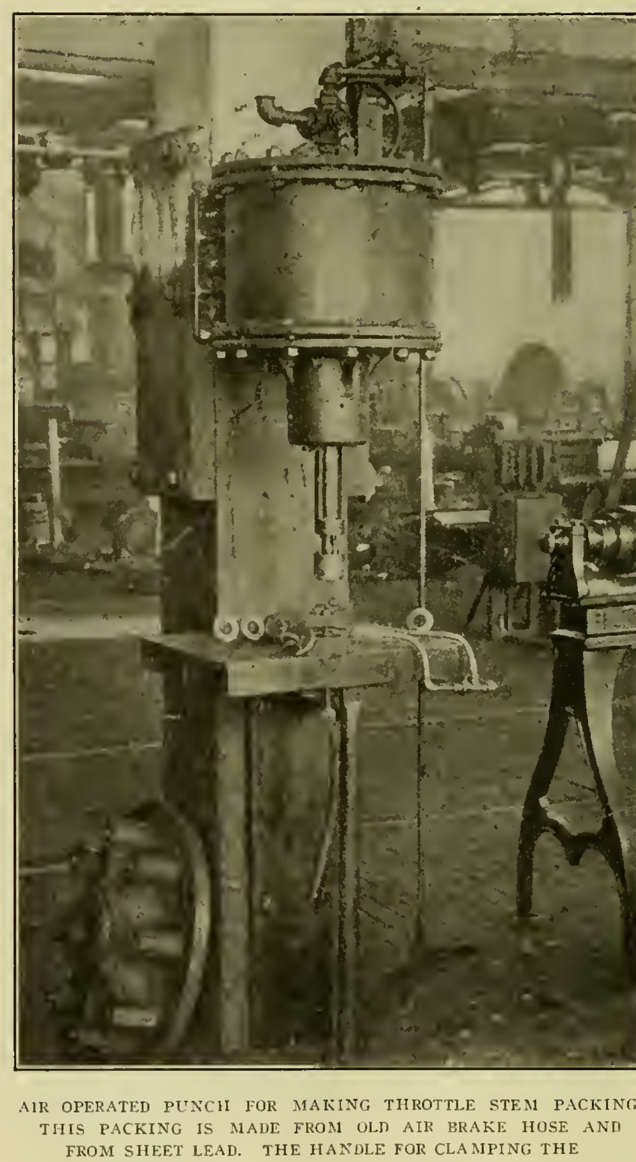


DETAIL OF JIG FOR DRILLING AND TAPPING ECCENTRIC STRAPS.

At the Readville shops a jig has been designed which permits all of this drilling and tapping to be done in one setting of the strap, the total time required being but one hour. This jig is shown in the accompanying illustrations and consists of a base plate secured to the side of the table of a radial drill. On this is mounted a circular plate of a size suitable to the straps to be drilled, which is free to revolve around its center connection to the base plate and carries straps and set screws for securing the eccentric strap. It is clamped to the base plate by a handle nut in the center and there is also a spring locking bolt that drops into the notches on the circumference of the circular plate, located in the proper positions to line up the different drilled or tapped holes. The plate, of course, can be revolved to other positions than those given by the locking bolt, if desired; in fact, it is capable of any adjustment in a vertical plane.

CUTTING GASKETS FROM OLD AIR HOSE.

Alternate layers of gaskets from old air brake hose and of sheet lead have been found to be a most satisfactory packing for throttle stems. As considerable packing of this kind is required at a busy terminal, at several places an air operated cutter has been designed, the illustration showing an excellent arrangement at the West Springfield shops.



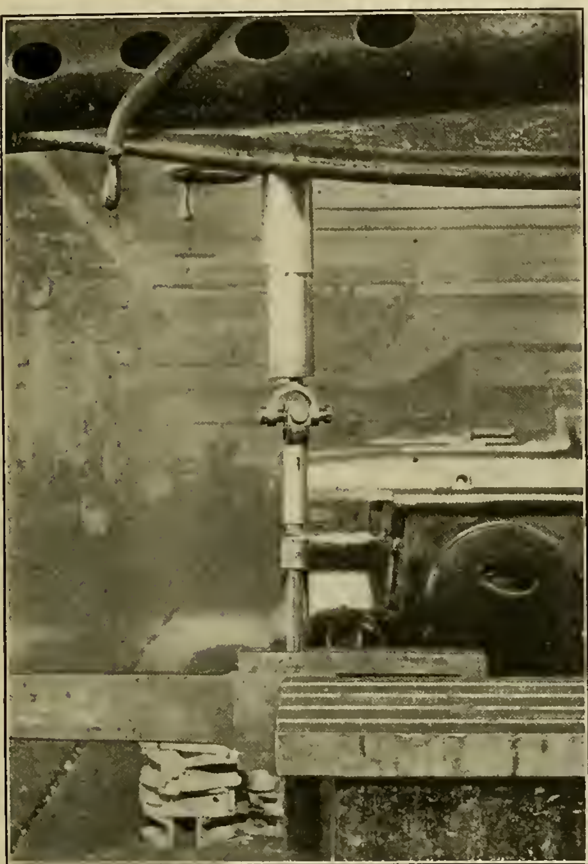
AIR OPERATED PUNCH FOR MAKING THROTTLE STEM PACKING. THIS PACKING IS MADE FROM OLD AIR BRAKE HOSE AND FROM SHEET LEAD. THE HANDLE FOR CLAMPING THE HOSE WHILE IT IS BEING CUT IS SHOWN BELOW THE TABLE AND THE AIR PIPES FOR KEEPING THE BLOCK CLEAN ARE CLEARLY SHOWN.

The cylinder is a 14 inch air brake cylinder mounted in a vertical position on a post, the piston of which is connected to the cutter. A three-way valve at the top is operated through gearing from a treadle located on the floor. On the bench the die is fitted with a clamp operated for holding the split hose by means of the handle shown underneath. Air passages in the die are provided for blowing out the chips and dirt. The cutter is arranged with an internal spring and ring so that the gasket is forced off of it as it is released. Both lead and rubber gaskets are cut on this press.

SELF-ADJUSTING KNUCKLE FOR DRILLING AND REAMING.

For the purpose of preventing the careful calipering and readjustment of the work on the table of a drill press, especially an upright drill, when reboring and truing up rod brasses, a self-centering knuckle has been designed by A. L. Finnegan, general foreman of the shops at West Springfield.

This knuckle is also used when reaming the bolt holes on



UNIVERSAL JOINT USED FOR REAMING HOLES FOR STRAP END BOLTS. THIS PERMITS THE OPERATING HEAD OF THE DRILL PRESS TO BE SOMEWHAT OUT OF LINE WITH THE HOLES AND DECIDEDLY INCREASES THE RAPIDITY OF THE WORK.

strap end rods and other similar work. The illustration shows it on a radial drill in connection with the latter operation.

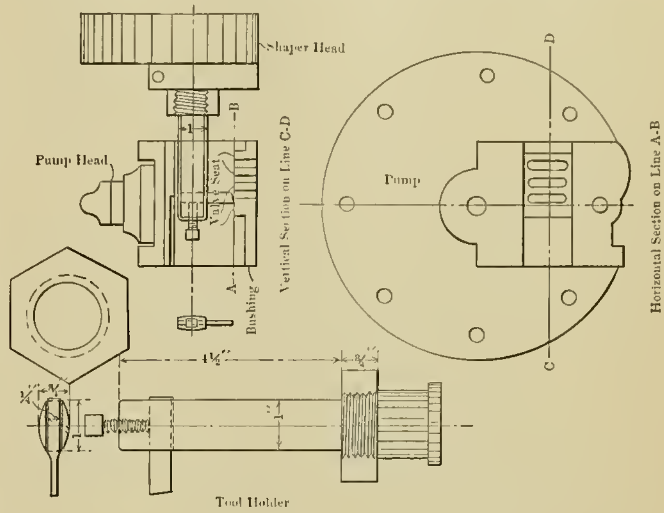
It consists very simply of two yokes of rigid construction pivoted on a central block with four arms at right angles. Each yoke has a very accurate fit and is given a side clearance of about ¾ inch. All bearings are carefully hardened and well lubricated. This will permit an offset in the vertical line equal to the clearance of the yokes and also acts as a universal joint permitting the reamer or cutter to center itself as the work requires.

This knuckle has been patented by its designer.

FACING MAIN VALVE SEAT OF AIR PUMP.

A plate with a rib is secured to the table of a shaper. This is provided with stud bolts in such a location that when the head of an air pump is secured to them the main valve seat is square and in line with the shaper head. A special tool holder somewhat resembling a boring bar is inserted in place of the tool clamp on the shaper ram and carries a small cutter at its outer end for facing the seat.

In this manner the valve seat can be accurately faced in a very short time, the table of the shaper being moved to give the feed and depth of cut required. The bolts holding the cylinder



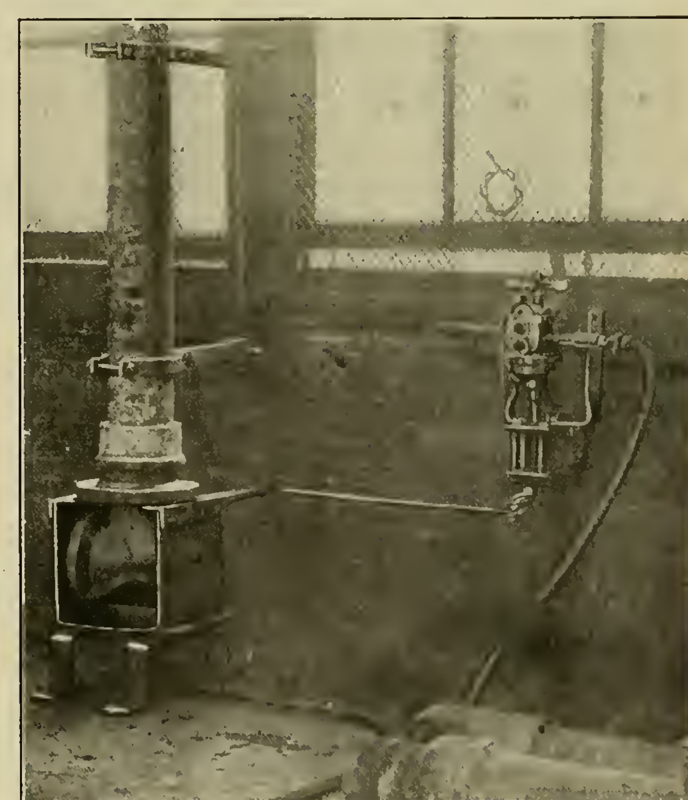
DETAIL OF JIG FOR FACING MAIN VALVE SEAT—WESTINGHOUSE AIR PUMP.

head to the plate pass through the holes in the head, which are in a standard position and thus assure the alignment of the valve seat with the shaper ram.

GRINDING DRY PIPE JOINTS.

A machine for grinding the joints between the dry pipe and T-head is shown in the accompanying illustration.

This consists of a framework made of plate and angles, which is mounted on a pivot secured to the small stand resting on the floor. The T-head is secured in this frame and the dry pipe is supported in a vertical position directly above, it being held by



GENERAL VIEW OF DEVICE FOR GRINDING DRY PIPE JOINTS.

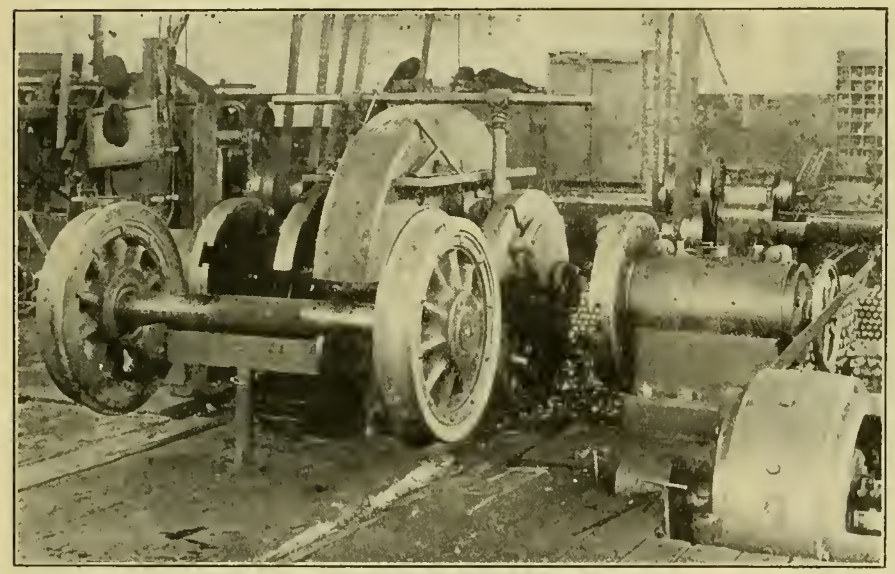
clamps extending out from the wall. A rod connects an arm from the frame to a crank connection on a short shaft in a brackets secured near by, that is driven by a small air motor.

The pivot supporting the oscillating frame can be raised and lowered a distance of a couple of inches by means of a small air cylinder located beneath it. In operation, after the pipe has been clamped in place and the T-head secured in the framework the oil and emery are placed on the joint and air is admitted to the small cylinder below which lifts the frame until practically the whole weight of the dry pipe is supported. The air motor is then started and the lower part oscillated at a fairly rapid rate and through a wide arc. Whenever it is necessary to renew the grinder the air is released from the lifting cylinder and the joint separated.

A similar arrangement has been designed for grinding the dry pipe in the front tube sheet. It works very much in the same manner as the one shown, the apparatus being secured in the front end. These machines were designed and are in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway.

CHUCKING CAR WHEELS IN A LATHE.

It is the usual custom to set a car wheel lathe in a pit below the floor level, so that the wheels can be rolled directly into or out of the machine. This is usually done by rolling them up the inclined surface of wooden wedges so as to raise them high enough to permit the centers to enter and then drive the wedges out before chucking the wheel. This arrangement not only requires the service of two men, but is also attended by more or less delay in shifting the wheels to get the centers to enter properly.



VIEW OF AN APPLIANCE FOR PUTTING WHEELS INTO A WHEEL LATHE. THE AIR CYLINDER UNDER THE FLOOR IS OPERATED BY THE HANDLE INDICATED BY THE ARROW.

At several shops a pneumatic device has been arranged that eliminates this trouble. It consists simply of a frame hinged to the bed of the lathe, the outer end of which is raised by means of an air cylinder below the floor level. This frame is of such a width that it forms a track on which the axle can roll. In using it the wheels are brought up when the frame is in a lowered position, the air is turned on, it is raised up sufficiently to permit the wheels to roll into the lathe without assistance and in a position that the centers can be closed without further adjustment and the wheel chucked with the services of but one man.

In addition to this device at some shops the tail stock is also air operated and the centers can be thrown in or out by simply turning an air valve.

These two devices, together with standard tools, have been found to greatly increase the output of a wheel lathe.

WOOD'S LOCOMOTIVE FIRE BOX.

Fred H. Snell, employed by the William H. Wood Locomotive Fire Box & Tube Plate Co. as locomotive expert to follow the services of the three locomotives on the New York Central Lines which are equipped with this type of firebox, in a recent report to his employers said in part:

"I found in the first place that the locomotives fitted with the Wood's firebox, which were of the 2400 class, were being run in comparison with locomotives of the 2800 class, that had a larger firebox heating surface and a considerably greater height from grate to water bars. They were also fitted with brick arches and were the very latest type of locomotive, whereas the engines fitted with our firebox were of the older type fixed over. I wish to draw your attention to this as the railroad company's expert had reported the locomotive, with our firebox as being about even on coal consumption. These comparisons, however, were made against the 2800 class, as stated.

"Upon my objection to this unequal comparison three of the 2400 class were substituted for the 2800 class and have been running in opposition to those fitted with our firebox and it is these locomotives that are referred to in my coal reports. You will note from these reports that our boilers are much better steamers and save a considerable amount of coal. The firemen have been changed on these engines from time to time, and as you will note from the tabulated reports, there has been little or no difference in the quantity of fuel used. The engineers and firemen who have run these locomotives speak in the highest praise in regard to the working of the boiler as against those not fitted with our firebox.

"The engineers tell me that they have not seen any tubes leaking when they had the engines in their charge, and from the careful examination I have given these boilers every day, up to the present time, I am satisfied that the tubes could be run for four or five months without putting an expander in them, and if it was not for the fires being dumped so often and the engines run into the roundhouses under their own steam, just taking cold air through firebox and tubes, they would go on working indefinitely without having any trouble from leakage.

"There has not been a broken staybolt since they were put into service. There was one defective throat sheet stay leaking, on account of it having the tell-tale hole drilled at an angle instead of straight in the center, which was replaced.

"After engine 2490 had been running nearly nine months, never missing a trip, I had a chance to examine it a number of times internally when the tubes were taken out, on account of the water being such that it honeycombed them very badly. I found the firebox and tube plates in first-class condition, and they do not scale any more than the regular plain fireboxes and tube plates. I also had occasion to examine engine 2494 when it was put in the shop to have the tubes fixed over, from same conditions. It was such a remarkable coincidence that they had not broken any staybolts in either boiler, that after the tubes had been put in again an order was issued for the drilling of twelve extra rows of radial staybolts, with 3/16 in. holes 2½ in. deep, to see whether any of the staybolts really were defective. This method is resorted to to find out whether the staybolts were in perfect condition.

"I am examining these boilers daily, after each trip, and they are showing up good. There have been no leaky or broken staybolts or leaky mud rings on any of the three boilers since I have been watching them. There have been several crown bolts leaking, from time to time, caused by dumping fires, but nothing of any consequence, and have easily been fixed.

"From the tabulated coal reports you will find that the saving is clearly shown to be over 15 per cent. and 20 per cent. over engines of the same class, for the same tonnage and the number of cars hauled.

"This report surely endorses your statement to me, that every extra square inch of surface put into the fireboxes and tube plates. by flanging, will give an account of itself in shape of fuel economy."

LEHIGH VALLEY R. R. TAKES UP FARMING.—An agriculturist is to be added to the staff of the Lehigh Valley Railroad Company. The officers of the company are of the opinion that more and larger crops can be raised on the farms along the line of the road, with proper instruction and encouragement. The new department begins work on April 1st, with F. R. Stevens, of Geneva, N. Y., at the head.

THE RAILROAD CLUBS.

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	April 5	Efficiency in Transportation	D. Crombie	Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	May 13			H. D. Vought	95 Liberty St., New York
New England	April 12	An Address	Hon. John W. Weeks	G. H. Frazier	10 Oliver St., Boston, Mass.
New York	April 15	Stresses Developed by Collision of Freight Cars	B. W. Dunn	H. D. Vought	95 Liberty St., New York
Northern	April 22	Railway Clubs	J. W. Kreitler	C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	April 22	Run, Repair or Transfer	R. L. Kleine	C. W. Alliman	P. & L. E. R. R. Gen. Office, Pittsburgh, Pa
Richmond	April 11	Train Lighting	Henry Schraeder	F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	April 21			A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	April 8	Freight Car Interchange	General Discussion	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	April 19	Electric Headlights	Prof. C. H. Benjamin	J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	April 11			W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

ELECTRIFICATION.

NEW YORK RAILROAD CLUB.

The report of a committee appointed by the president to consider the subject of electrification of steam railroads was read at the annual electrical night of this club on March 18. This report briefly reviewed the whole subject and gave a very broad and comprehensive view of the present status of electrification of steam railroads. It considered the subject under the following headings: history; characteristic features of electrification, under which the subjects of flexibility, effect of weather conditions, use of equipment, power, capacity, cleanliness and collateral advantages were considered; the reasons for considering electrification, that included a discussion of increase of facilities, increase of earnings and legislative enactment. The cost attending installation was the fourth division and included direct cost, contingent cost, ultimate cost and systems of electrification. The fifth chapter was on the advantages and disadvantages of electrification, which were enumerated carefully, following which the features to be considered for future electrification were briefly summed up and the report was closed with the following conclusions.

(1) No general information is available on the basis of which steam railroads, as a whole, would be justified in electrifying terminals or main lines, solely on the grounds of economy.

(2) Careful investigation is necessary to decide if electrification of terminals and suburban districts would be warranted in order to increase earnings.

(3) More attention should be given to the possibilities of electrification in connection with heavy grades, and at other places where an increase in facilities is needed.

(4) It is not likely that conclusive data on the economy of electrification will be available until electrification is extended over a complete steam locomotive stage.

(5) The electrification for passenger terminal and suburban service is now more or less settled as to method, but for freight and general trunk line service it is in the experimental stage.

(a) The types of locomotives for various service have not been determined, though progress is being made.

(b) The method of secondary distribution (working conductors), needs much development The third rail is thoroughly reliable and efficient, but unsuitable for complicated switch work. In its present form it has only been used for voltages up to 1,200.

(c) The overhead system for high voltage working conductors also needs much development. Few, if any, are satisfied with present designs, and many changes are proposed.

(6) The steam railroad men and electrical engineers should work together in as close harmony as is possible so as to produce results that will be as free from mistakes and experiments as is possible in any developing art.

(7) Each problem must be studied on its merits and a decision can only be made after careful study of the conditions pertaining to each situation.

(8) The electrification of large freight terminals has not as yet been attempted, nor satisfactorily worked out, therefore it is necessary to proceed with caution in this matter and the problem must be exhaustively studied and new developments made before it would be justifiable to make such an installation. The electrification of any large freight terminal would involve a number of roads, and cannot be undertaken independently, without the co-operation of all the railroads affected, on account of the relations existing among the various roads in the interchange of freight traffic.

Committee—W. J. Harahan, Chairman; J. H. Davis, L. C. Fritch, Edwin B. Katte, Wm. McClellan, C. O. Mailloux, H. M. Warren, and G. W. Wildin.

Among those who discussed the report was George Gibbs, who stated that the system to be used should be adapted to the condition, and it is in no way possible to say that one system is better than another under all conditions.

L. B. Stillwell considered that the most important question now was to develop standards of electrification, mentioning three things that should be standardized in the near future. First, the position of the third rail; second, position of overhead trolley, and third, frequency.

W. S. Murray threw on the screen a number of lantern slides showing the latest development of the work on the New York, New Haven & Hartford electrified section. In addition he discussed the report very fully, disagreeing with the committee's findings in several respects.

G. M. Basford pointed out that the introduction of the Mallet compound locomotive had removed the necessity for electrification in many places. He also drew attention to the fact that the refinements of locomotive operation have not begun to be put into general use, and that these economical factors will be taken full advantage of before electrification becomes general. His whole discussion was woven around the fact that each particular instance that offered a possibility for electrification should be studied by itself and that it was not possible to arrive at any broad conclusions at the present time.

After the report had been discussed by several other members it was brought to a close by William McClellan, who pointed out very clearly that this report did not represent the complete ideas of any single member of the committee, but simply stood for what they were all able to agree upon.

ECONOMY IN THE OPERATION OF LOCOMOTIVES.

RAILWAY CLUB OF PITTSBURGH.

At the January meeting of this club J. R. Alexander, general road foreman of engines of the Pennsylvania Railroad, at Altoona, presented an excellent paper on the subject of "Supervision Tending to Economy in the Operation of Locomotives." In this paper he strongly urged the matter of education for enginemen, particularly firemen. The subject was one which brought forth an excellent discussion, that, in the main, agreed with the author in his contentions.

PASSENGER CAR LIGHTING.

CANADIAN RAILROAD CLUB.

At the February meeting there were presented several papers on the subject of passenger car lighting, each being prepared by an expert in one particular kind of lighting, who confined himself to his own specialty. This included a description of the

Commercial Acetylene Company's method of lighting; the Canadian Gold Car Heating & Lighting Company's acetylene lighting; a general paper by W. L. Gray on the Stone system of lighting, and a paper by L. R. Pomeroy on the Safety Car Heating & Lighting Company's method of car lighting by Pintsch gas. The latter paper was fully illustrated and forms an excellent brief treatise on modern Pintsch gas lighting.

At the March meeting of this club a paper by G. I. Evans on "An Experimental Articulated Mallet Locomotive," which appeared on page 81 of the March issue of this journal, was presented.

STEEL CAR CONSTRUCTION.

NEW ENGLAND RAILROAD CLUB.

In a very complete and well illustrated paper C. R. Harris discussed the construction of steel cars at the February meeting of the New England Railroad Club, giving a graphical analysis of the weight, cost, strength and general merits of pressed steel as compared with structural shapes for car structures, the comparison being very generally in favor of the latter construction.

The paper was discussed by Mr. Millar, Prof. C. F. Allen, Mr. M. V. Ayres and other members. The general consensus of opinion seemed to be in favor of structural shapes for car construction.

ELECTRIC CAR LIGHTING.

CENTRAL RAILWAY CLUB.

Mr. J. R. Sloan presented a most interesting paper on the above subject at the March meeting of this club. He first considered the general advantages of electric lighting and followed with a detailed discussion of the different types of electric lighting, pointing out in each case the advantages and disadvantages. It is the opinion of the author that a great majority of the future electric installations will be of the axle generator type.

STEEL FREIGHT CARS.

NORTHERN RAILWAY CLUB.

W. S. Atwood, mechanical engineer of the Dominion Car & Foundry Company, presented a brief but comprehensive paper on "Steel Freight Cars" at the January meeting of this club. A lively and interesting discussion followed, in which the experience of a large number of car experts was given.

STORES DEPARTMENT.

WESTERN CANADA RAILWAY CLUB.

The subject at the January meeting was "The Store Department and Its Relation to Other Departments," the paper being by A. E. Cox,. storekeeper of the Canadian Northern Railway. This paper briefly discussed the activities of the store department and pointed out its intimate relationship with other departments and how by the proper co-operation its work could be facilitated and its assistance to other departments be increased.

The discussion was active and brought out a large number of very interesting points on the practice in the various store departments of other roads.

ST. LOUIS RAILWAY CLUB.

At the April meeting the annual election of officers will take place. The nomination committee has placed the following gentlemen in nomination: President, J. E. Taussig; 1st vice-president, H. J. Pfeifer; 2d vice-president, Chas. Burlingame; 3d vice-president, J. B. Carothers; secretary, B. W. Frauenthal; treasurer, C. H. Scarritt; for member of executive committee, E. F. Kearney; for member of executive committee, W. H. Elliot.

RAILROAD PAY IN NEW YORK STATE.—The annual report of the Public Service Commission of the second district of the State of New York, for the year 1908, gives the average rate of pay received by the various employees of the railroads. For the railroad which has the largest number of employees, the figures are as follows:

	Number.	Average Pay per Day.
Engineers	2,015	$4.95
Firemen	2,023	2.88
Conductors	1,591	4.05
Other Trainmen	3,713	2,84

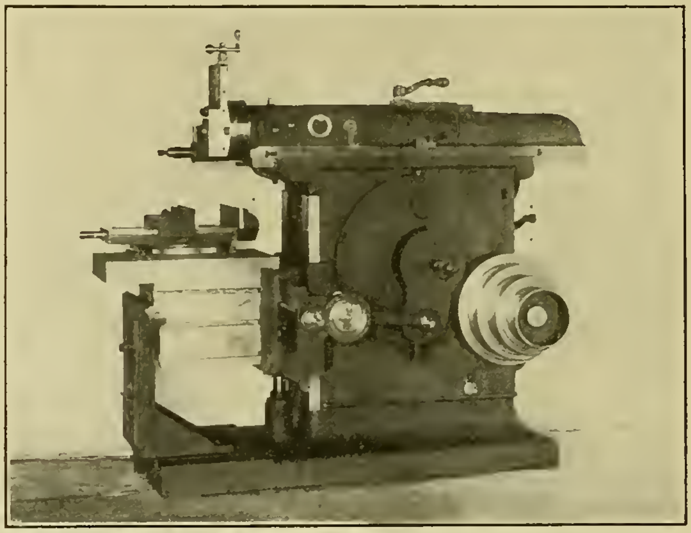
NEW 24-INCH SHAPER.

Stockbridge shapers are noted because of their two-piece crank motion that gives a stroke to the ram of even speed throughout the entire length of the cut and a very quick return stroke. Tests which have been made at the Worcester Polytechnic Institute indicate that 25 per cent. less power is required for the same amount of work with this type of shaper than with the plain crank motion type.

With the new 24-inch machine that has recently been designed and is shown in the accompanying photograph, this type of crank is again employed and the machine has been very carefully designed for ample strength and rigidity in all its parts. Some changes have been made in the detail construction, with the idea of simplifying the arrangement as compared with the previous machines.

As can be judged from the back gear ratio, which is 30 to 1, this machine is very powerful, but in addition to being a high duty shaper it also maintains the highest standard of accuracy.

Where previously a taper packing was used to take up the wear of the side thrust of the ram, on this machine there is a



24-INCH STOCKBRIDGE SHAPER EQUIPPED WITH A TWO-PIECE CRANK MOTION THAT GIVES A UNIFORM CUTTING STROKE WITH A VERY RAPID RETURN.

solid gib. This is bolted to the bed and when in place gives practically the same condition on both sides of the ram. The wear can be taken up by adjusting screws, the gib, however, being solidly bolted to the bed after being adjusted.

The cross feed mechanism has been simplified over the previous design and made stronger. The feed rod adjusts itself to any position of the bar and, without changing its position, feeds the table in either direction and automatically stops at either end of its feed.

The method of supporting the driving cone is also worthy of notice. It is carried on a sleeve supported by a large self-oiling bearing that takes all strain from the cone off from the driving shaft. A speed box with a single drive pulley can, however, be applied to the same shaper if desired, the parts being interchangeable.

With the cone pulley on direct drive the ratio is 8 to 1, but with the back gears in the ratio is 30 to 1. The cone gives eight changes of speed to the ram, with a range in strokes of from 8 to 90 per minute.

A few of the principal dimensions of this shaper, manufactured by the Stockbridge Machine Co., Worcester, Mass., are:

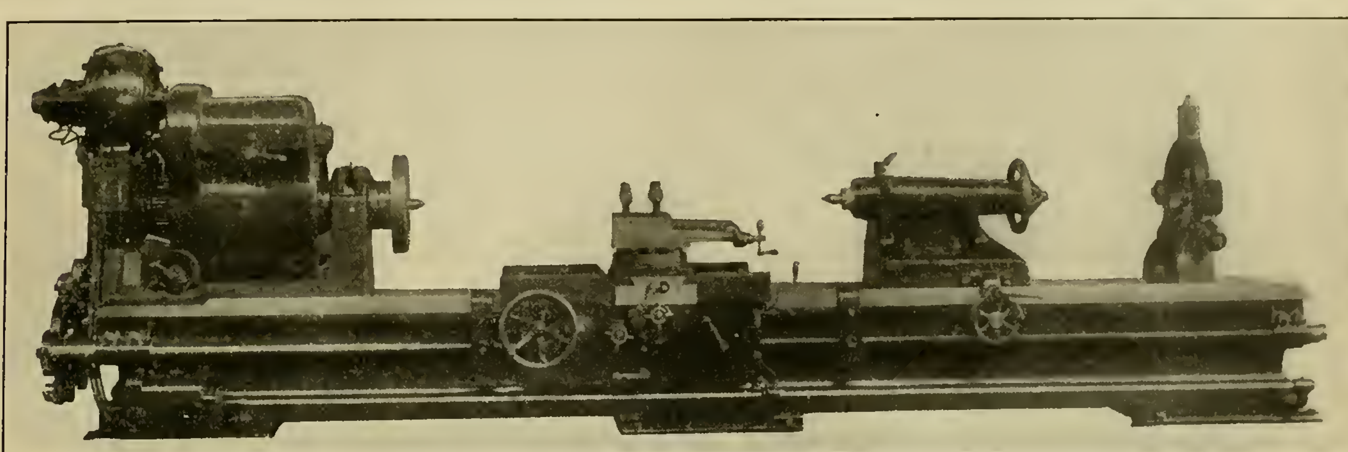
Actual length of stroke	24¾ in.
Vertical traverse of table	15 in.
Horizontal traverse of table	30 in.
Top of table	16 in. x 24 in.
Length of ram bearing in column	36 in.
Width of ram bearing in column	12 in.
Net weight of machine	4400 lbs.
Floor space required	102 in. x 52 in.

36 INCH MOTOR-DRIVEN LATHE.

In all the recently constructed railroad shops the heavy machine tools are located so as to be served by the travelling cranes and are usually driven by individual motors either attached to the tool or located on the floor or column near by.

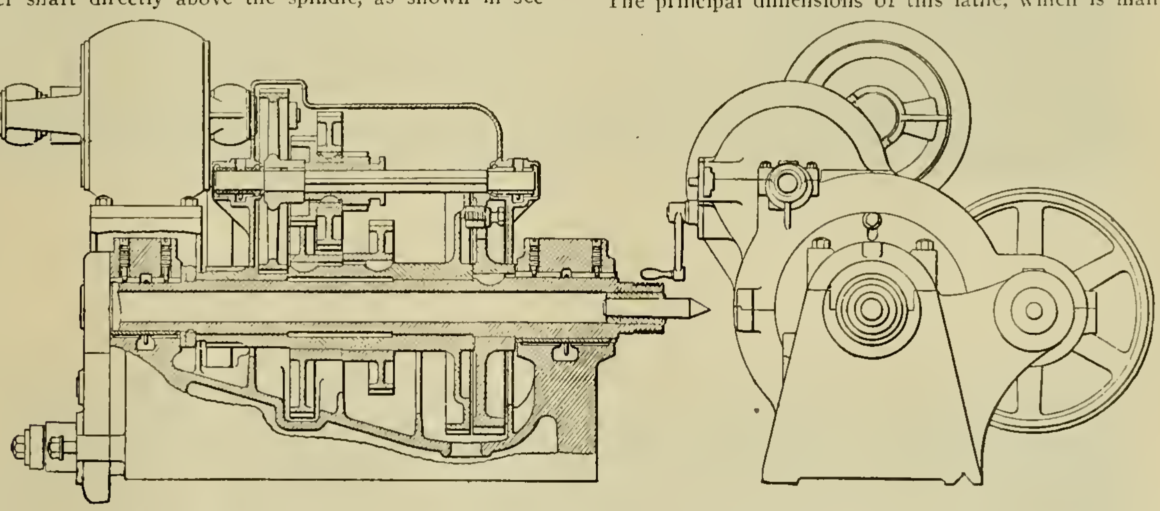
A large lathe that has the motor attached to the headstock and is carefully designed throughout for rigidity, power and ease of operation, is shown in the illustration.

This machine has a swing of 37 inches over the bed and 24 inches over the carriage. The driving motor is of 7½ horsepower and it has a speed range varying between 600 and 1,200 revolutions per minute. Special attention has been given to the design of the headstock, which is completely enclosed and of symmetrical proportions. This enclosed type of headstock not only lessens the danger of accident, but greatly adds to the massiveness and strength of this part. The driving mechanism is provided with gears having wide faces, and is strongly constructed throughout. There are six mechanical changes of speed, which, together with the changes obtained from the motor, give all the necessary speeds required for a lathe of this size.



36-INCH MOTOR DRIVEN ENGINE LATHE—SPRINGFIELD MACHINE TOOL CO.

The manner of driving is as follows: A rawhide pinion mounted on the motor shaft engages directly with the large gear keyed to the upper shaft directly above the spindle, as shown in sectional view. This upper shaft also carries a sliding set of three gears adapted to engage individually with three gears on the spindle, and thus three speeds are obtained as with a three-step cone pulley. A rack and pinion are used to operate the sliding gears and the pinion is controlled by a handle on the front end of its shaft, which is shown in both views. These three changes of speed are doubled by the back gears, and additional speeds are obtained by using a variable-speed motor. In this way practically all the necessary speed range for a lathe of this size is secured.

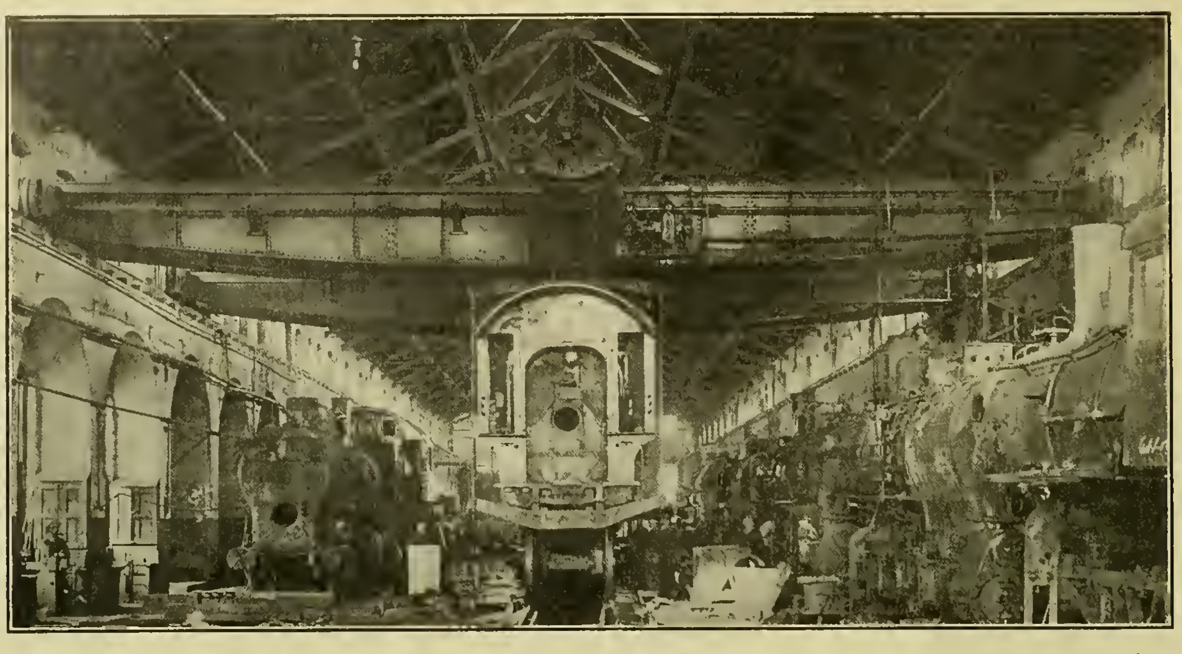


MOTOR APPLICATION TO HEAD STOCK OF 36-INCH LATHE—SPRINGFIELD MACHINE TOOL CO.

The controller of the motor is mounted on the right side of the carriage, so that while it is convenient for the workman, it is not located so as to interfere with the operation of the lathe. As the illustration shows, this controller is connected through bevel gears to a splined rod extending the length of the bed, which transmits the movement to the starting box. This method of operating the motor from the carriage has proved so satisfactory that all the motor-driven lathes made by this company are so arranged. This lathe is adapted to cut threads ranging from 1/16 inch to 4 inches pitch. The lead-screw is prevented from sagging by a support which travels on the bed with the carriage and automatically stops off at certain points. This insures a longer life to the lead-screw and more accurate work from the machine. The lathe is equipped with power feeds for either longitudinal or cross movements, and, in addition, there is also power feed for angular positions of the compound rest. A dial in front of the headstock is so arranged as to give three changes of feed for screw cutting. There are also two intermediate positions in which the lead-screw remains stationary. This dial, together with a few change-gears, gives all the necessary changes ordinarily required for feeding or screw cutting on a lathe of this size.

The principal dimensions of this lathe, which is manufactured by the Springfield Machine Tool Co., Springfield, Ohio, are as follows:

Length of front journal, inches	10
Diameter of front journal, inches	6
Length of rear journal, inches	7
Diameter of rear journal, inches	4⅞
Hole in spindle, inches	3¼
Tailstock diameter, inches	4
Swing of lathe, inches	36
Length of bed, feet	18
Size of motor, horsepower	7½
Speed range of motor, rev. per min	600 to 1200



VIEW OF TWO 40-TON CRANES WHEELING A LOCOMOTIVE IN THE ROANOKE SHOPS OF THE NORFOLK & WESTERN RAILROAD.

GENERAL VIEW OF THE FOUNDRY AT THE ROANOKE SHOPS OF THE NORFOLK & WESTERN RAILROAD. SEVEN NILES CRANES ARE SHOWN IN THIS ILLUSTRATION. THREE ARE 15-TON CAPACITY, HAVING LATTICE WORK GIRDERS; THE OTHER FOUR ARE OF THE WALL TYPE.

A 30-TON NILES CRANE WITH A 68-FT. SPAN LIFTING A LARGE LOCOMOTIVE BOILER AT THE ROANOKE SHOPS.

RAILROAD SHOP CRANES.

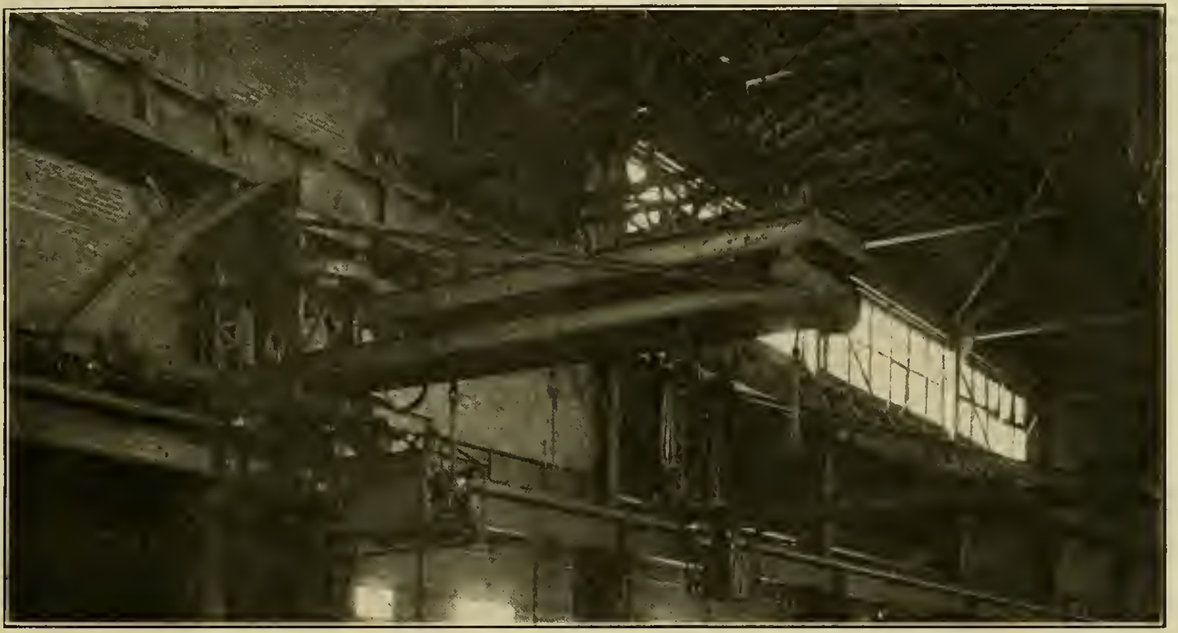
Good crane service is so general in modern railroad shops that it seldom attracts any attention, but the installation of cranes at the Roanoke shops of the Norfolk & Western Railroad is so complete and extensive that it is deserving of some comment.

The erecting shop is provided with two 40-ton cranes, 59 ft. span, of the four motor type, that have a 5 ton auxiliary hoist, located on and forming part of the main trolley. The auxiliary operates at very high speed. These cranes, as well as the general view of the shop, are shown in one of the illustrations. They have no particularly unusual features, being of the double plate girder design, commonly used with this size crane. Two 30-ton cranes, of 68 ft. span, serve the boiler shop. These are of the three motor type, but provision has been made for the application of a high speed auxiliary hoist if desired at any future time. The bottom block of these cranes is provided with a special hook for accommodating the slings when one crane lifts an entire boiler, which operation is illustrated in the photograph. Three cranes of 15 tons capacity of the same general design as those in the boiler shop serve the general foundry.

It is in the wheel and soft iron foundry that unusual provision has been made for complete crane service. In this building there are nine electric cranes, three of these are of the lattice girder construction, 86 ft. 8½ in. span and 15 tons capacity. They are of the three motor type and cover the entire floor area of the main foundry. This type of construction is particularly well suited for this capacity of crane, and gives a very light dead weight for large capacity. On each side of the foundry there are two traveling wall cranes of 2-tons capacity and 25 ft. reach of arm. These run on a track extending the entire length of the building on both sides. One of these wall cranes on each side is of the stationary arm type equipped with a single hoist and operated by three independent motors controlled from a cage on the crane. The other two wall cranes are of the revolving type and arranged to operate by power through an angle of 90 degs. One of the illustrations gives a close view of both of these types of wall cranes. The revolving type are equipped with special four hook trolleys, each of which is operated by an independent hoisting mechanism equipped with a double disc brake. A special master controller in the cage is arranged so that any hoist can be operated independently or all in unison, as desired.

These cranes are used principally for conveying the wheels which are cast on either side of the foundry to a point where they can be picked up by the traveling crane, that passes over the annealing pits; this is also provided with a four hooked trolley. The wheels are thus carried four at a time and swung into positions so that when lowered they are located to permit the traveling crane to pick them up and convey them to the annealing pits without any moving by hand.

These cranes are electric driven throughout and were designed and constructed by the Niles Bement Pond Co., 84 Liberty street, New York.



REVOLVING TYPE WALL CRANE WITH A FOUR HOOK HOIST. THIS CRANE IS USED FOR TRANSPORTING WHEELS IN THE WHEEL FOUNDRY AND HAS A POWER CONTROLLED SWING OF 90 DEGS. ON EITHER SIDE OF ITS PRESENT POSITION. THE HOOKS ARE OPERATED INDEPENDENTLY OR IN UNISON, AS DESIRED.

RAILROAD RELIEF FUNDS.

The great extent to which aid is extended by workmen to each other through co-operative insurance and benefit funds or societies in cases of disability, death, or other adversity and the tendency of employers to assist in the support of such funds and to grant pensions to superannuated and disabled employees are shown in the twenty-third annual report of the Commissioner of Labor, just published. In connection with this report about 1,200 such funds were investigated by the Bureau of Labor.

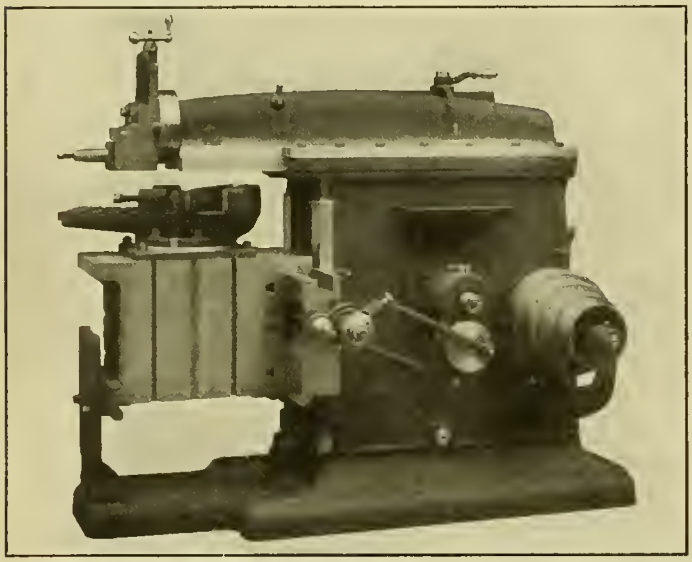
Information in regard to 50 railroad funds is included in the report. Of these, 14 are pension systems maintained entirely by the employing companies. Pensions are as a rule based on age and length of service, usually on the basis of 1 per cent. for each year of service of the average pay for the ten years next preceding retirement. In most of the systems pensions for superannuation are granted to employees retired at 65 or 70 years of age, after from 10 to 30 years of service, and for incapacity to employees 60 to 69 years of age.

Employees contribute all or a large part of the revenues of the remaining 36 funds investigated, 8 only being contributed to by the companies involved. One company contributes 50 per cent. of the revenue, and the remaining 7 amounts varying from 20 per cent. to less than 1 per cent. of the amount contributed by the employees. In these 8 funds there are provisions for relieving the funds from all claims for benefits if a suit for damages is brought against the company. Thirty-one of these 36 funds pay benefits for temporary disability, ranging from $2.50 to $20 per week. Thirty-four pay death benefits, the average payment per death having been $588. Several of these funds pay benefits in cases of permanent disability, and one pays a superannuation benefit.

24-INCH BACK GEARED CRANK SHAPER.

It is the proportion of the power delivered by the motor or belt to the machine which appears as work at the point of the tool that in the long run determines the value of a machine tool. This is so because the tool which does deliver the largest proportion of power must of necessity be very rigid, well designed and accurately built. Of course the matter of convenience to the operator and range of adjustment are of great importance, and in practically all of the modern designs of tools have been given the attention they deserve.

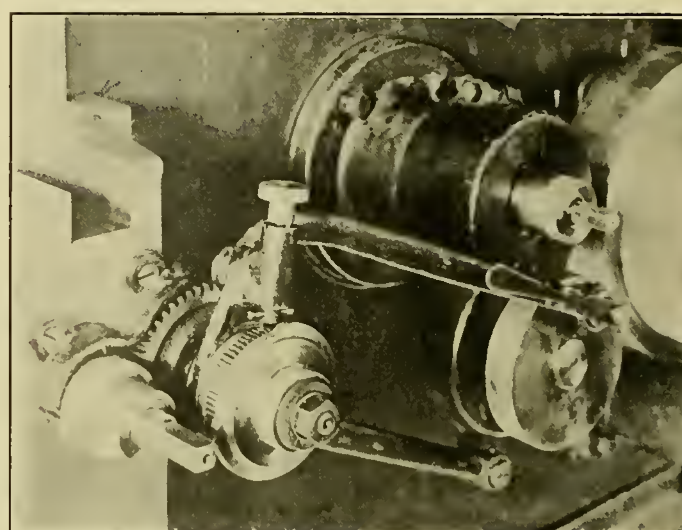
The 24-inch back geared crank shaper shown in the illustration manufactured by the Queen City Machine Tool Company, driven by a constant speed motor through a gear box (see *American Engineer*, May, 1908, page 196), removed 13 cu. in. of cast iron per minute with a 32 ft. tool travel, the highest rating of the wattmeter attached being 7 1-4 h.p.. This, it will be admitted, is a remarkably good record, and it is for the performance of such work as this continuously and with accuracy that the tool has been designed.



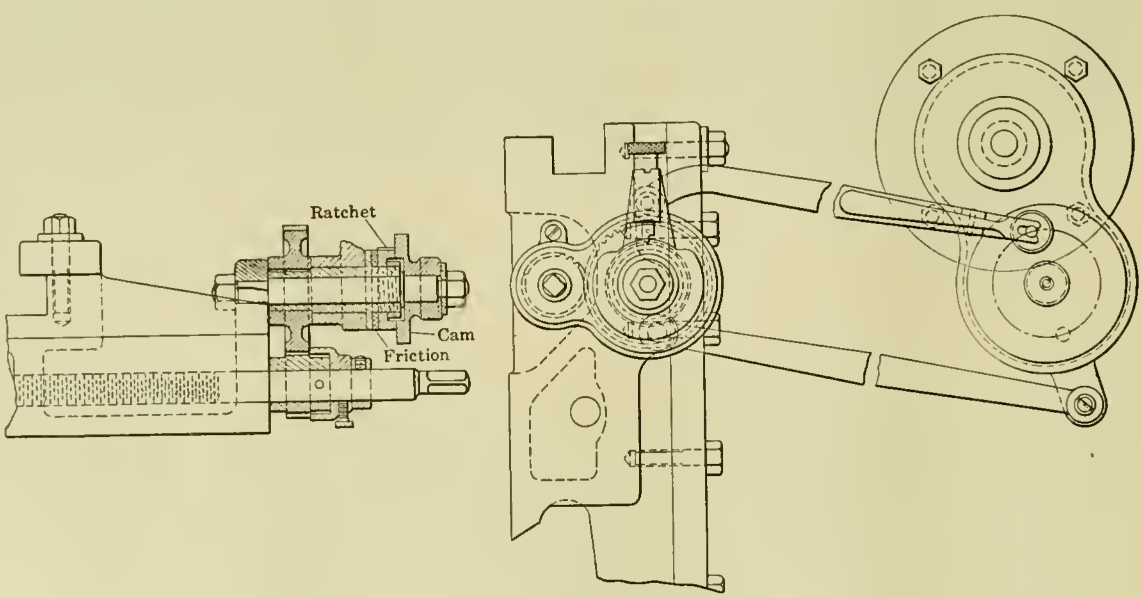
QUEEN CITY 24-INCH SHAPER WITH BELT DRIVE. NOTE THE LONG, LOW APPEARANCE.

In the general arrangement the most noticeable feature is the extreme length of base, which is 17 in. longer than the average tool of this size, and the height over the ram, which is 6 in. less than the average. This not only makes it easier to reach the upper adjustment, but also gives a longer ram bearing in the column and a stronger and more steady operation of the tool. The tool is designed to give a cut in cast iron 1-2 in. deep by a 1-4 in. feed, which cut can be continued indefinitely with absolute accuracy.

Two features of the design are worthy of special comment, one being the automatic feeding mechanism and the other the table support. The former provides 16 changes of feed from 1-64 to 1-4 in., which can be made in either direction almost instantly while the machine is in operation. The feed rod is driven through gears, including a friction, from a ratchet on an auxiliary shaft. This ratchet is operated by a latch oscillated by the feed rod. The number of notches which are caught in each oscillation are determined by the position of the cam located next to the ratchet and adjustable by hand. This dog or latch can be lifted and by a half turn of a handle at the top can be held out of operation. To change the feed from the forward to the back stroke it is simply necessary to lift the plunger connecting the feed rod to the driving gear and allow this gear to travel half a revolution when the plunger will drop into the hole in the opposite side of the plate. The feed and distance rods act automatically as the height of the rail is changed. The feed screw has an adjustable graduated collar reading to .001 of an inch.



CLOSE VIEW OF FEEDING MECHANISM ON A QUEEN CITY 24-INCH SHAPER.

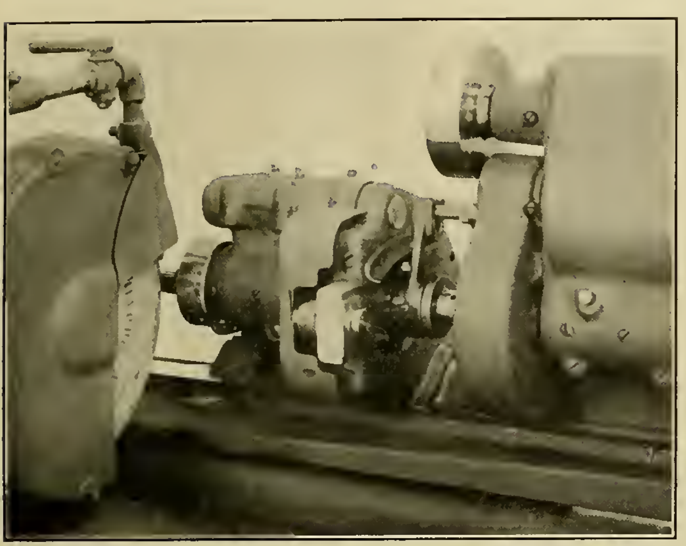


DETAILS OF FEEDING MECHANISM ON QUEEN CITY 24-INCH SHAPER.

The table support raises and lowers with the rail, is always in line and needs no setting up. It is so arranged that no dirt can get in the bearing and its location at the extreme end of the table makes it particularly efficient. This feature has been given a large amount of study and it is believed that it is the most satisfactory arrangement that it is possible to obtain.

CAM GRINDING.

The accurate grinding of a large number of parts of irregular shape on a regular grinding machine can be accomplished by means of an attachment which has recently been designed by the Landis Tool Co., of Waynesboro, Pa., and is shown in one of the illustrations. This attachment is simply clamped to the table of the regular universal and plain grinders and the driving arm on the end of the spindle is connected with the regular driver on the face plate of the grinder. The attachment is constructed on the swinging principle, the spindle head being suspended from the hinged bearing located directly above. The work to be ground and the master cam are mounted on the same spindle.



REAR VIEW OF ATTACHMENT TO PLAIN GRINDING MACHINE FOR GRINDING CAMS.

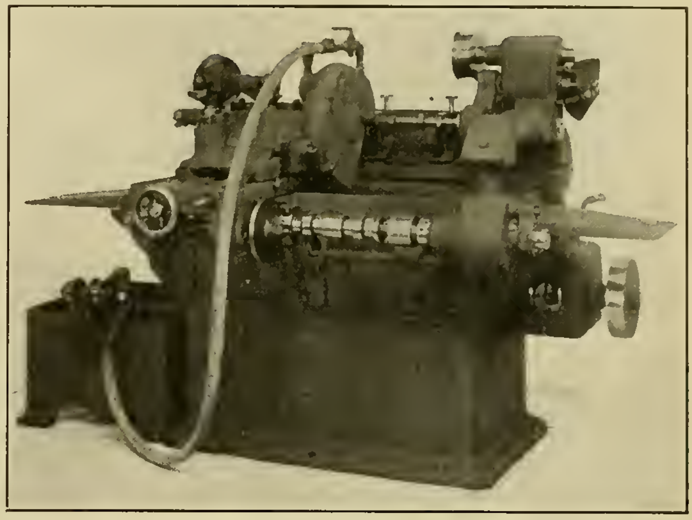
With this attachment the master cams are ground from actual size model cams. In doing this the master cam is mounted on the working end of the spindle, while the model serves as a master on the other end, this operation being exactly the same as illustrated for grinding the work. The master is enlarged, the cylindrical portion never being less than 3 in. in diameter; this in a majority of cases being more than double the size of the work.

The swinging or oscillating motion on the spindle is produced by the master cam working in engagement with a stationary guide, with which it is held in contact by a spring. The slight change in the cam form caused by the reduction of the diameter of the grinding wheel by wear is compensated for by a set of master cam shoe plates, that fit over the guide against which the master is held in contact. These are arranged in series to be changed at each 1 in. reduction in the size of the grinding wheel.

One of the illustrations shows a grinding machine that is designed specially for cam grinding, where the cams or eccentrics are integral with their shafts. With this machine working on gas engine cam shafts, master cams can be provided so as to grind the full set of inlet and exhaust cams at one setting. In this machine the principle of action of the grinding wheel and work for producing the cam form is reversed to that of the cam attachment of the regular machine. In this case the grinding wheel head moves by a cross reciprocating motion that is actuated by the master cam, and the work is carried by the regular stationary centres of the machine. The principle of compensating for wear is the same as in the attachment. This machine can be used for plain straight grinding whenever desired.

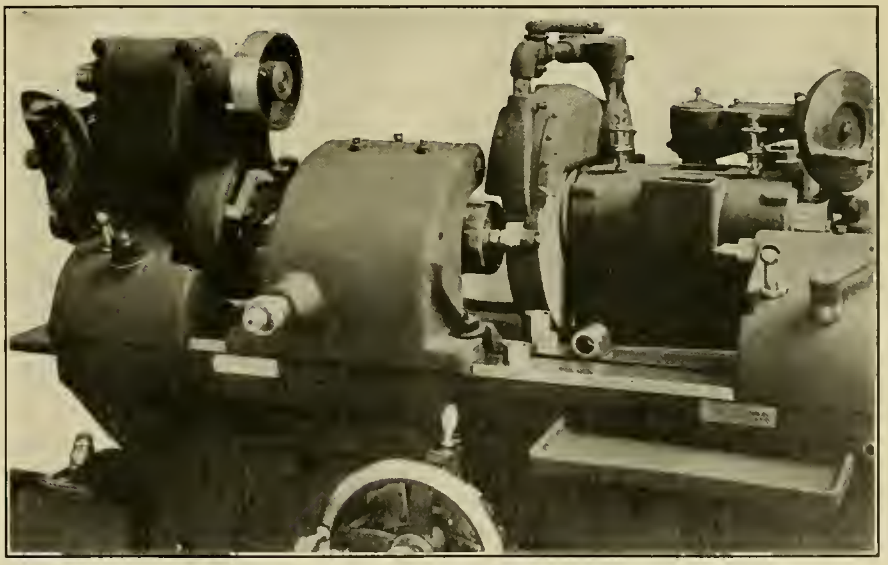
THE SELLS ROLLER BEARING.

A new type of roller bearing, invented by John D. Sells, for many years with the Standard Roller Bearing Co., and now manager of the Royersford Foundry & Machine Company, Royersford, Pa., is shown in the illustration. The particularly novel features of these bearings are their universal adaptation, the ease with which they may be substituted for the old style bearings, and the interchangeability of all parts.



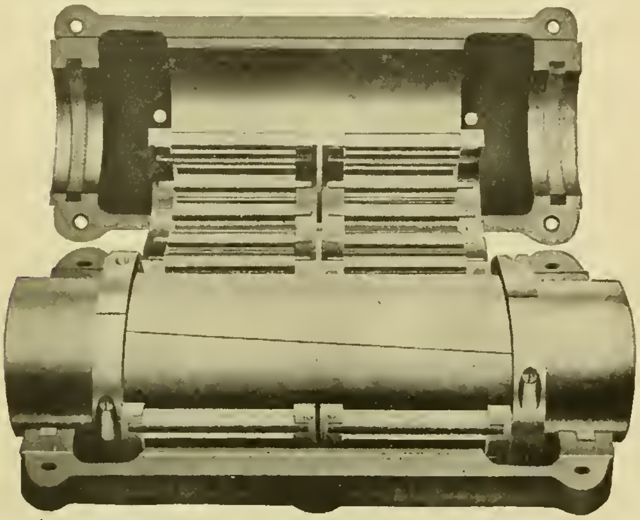
LANDIS MACHINE FOR GRINDING CAMS.

The bearing consists of four parts—a split bushing, a split collar to clamp this bushing to the shaft, a split cage for containing the rollers, and finally a split box to inclose the other three parts. The split bushing is of hardened steel and is designed to prevent the shaft from becoming cut and scored by the case hardened steel rolls. These bushings are furnished in different thicknesses, so that each size of bearing is adaptable to three different diameter shafts. This permits a user a certain latitude in making changes and does not require the dealer to



FRONT VIEW OF ATTACHMENT TO PLAIN GRINDING MACHINE FOR GRINDING CAMS.

handle a large stock to cover all possible requirements. Any bearing of a given size can be fitted to any ceiling or wall hanger or pillow block of a corresponding size, either for a new installation or for replacing old style plain or self-oiling bearings.



SELLS' ROLLER BEARING FOR LINE SHAFTS. THIS SHOWS THE TWO CAGE ARRANGEMENT.

For replacements it is not necessary to dismantle the shafts, as the bearings are split and as easy to apply as a steel or wood split pulley. The same advantage exists in new equipment.

The two halves of the bearing are fitted together with milled joints to make them dustproof. As a further preventive against dust working into the bearings a heavy felt wiper is inserted in each end of the box, which also serves to retain oil in the bearing. Tapped holes in the top of the box allow the attaching of oil cups, and drain holes are drilled so that the box may be flushed with kerosene or other cleansing fluid if the oil should thicken or gum.

For shafts 3 11/16 in. in diameter or larger a double roller cage of the type illustrated is employed to provide a larger and more suitable bearing surface. For ordinary shafting only one cage with a box of sufficient length to cover it is used. Another advantage of these bearings is that all parts are interchangeable. Thus should any part of the bearing become mislaid or accidentally broken it may be easily replaced and the expense of a complete new box is saved. This interchangeability is also an advantage where it becomes necessary for any reason to change the bearings of a shaft. If the load is too heavy for a single cage all that need be ordered to provide for the increase is another single cage and a suitable box.

COMBINED CAR MORTISING AND BORING MACHINE.

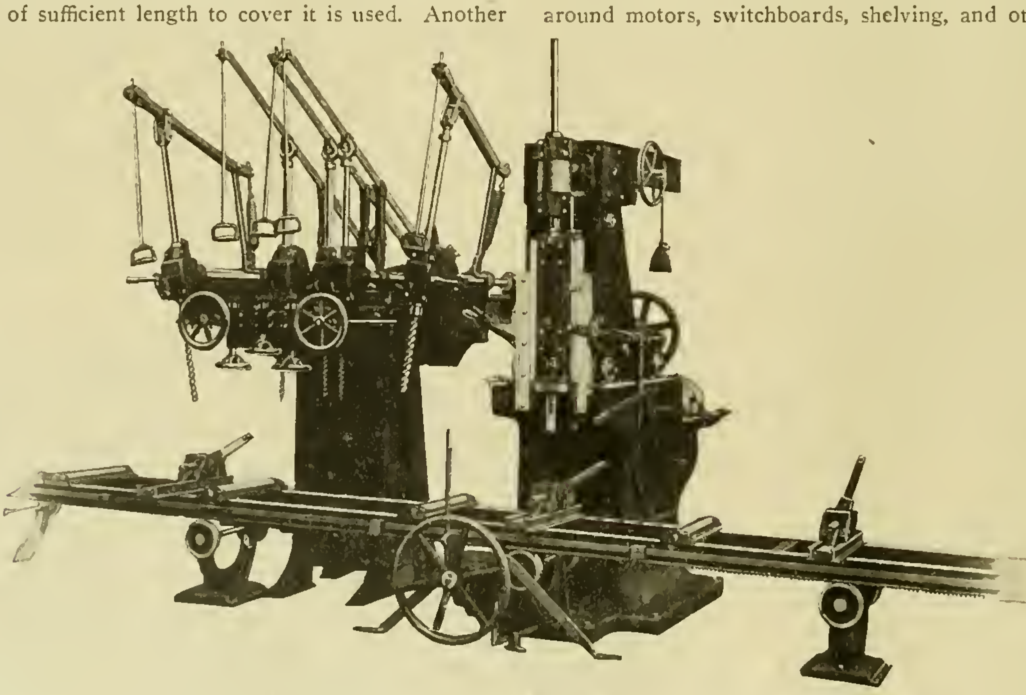
In a number of instances it has been found very advantageous to locate wood working tools for heavy work so that two or more operations can be carried on at the same time, or at least consecutively. This is usually done by arranging a common carriage table so that when the sill or other part is clamped in place several operations can be performed upon it as it is carried along the table. The illustration shows a combined car mortizing and boring machine arranged in this manner.

The Hamilton five spindle boring machine used in this case was fully illustrated and described on page 213 of the May, 1909, issue of this journal; reference to this article will show its many excellent features and arrangements.

The vertical hollow chisel mortiser, located alongside of it, is designed for the heaviest character of work and takes chisels up to 2½ in. square. The chisel ram, 29 in. long, is mounted in the front of the housing in dove tail slides and is counterbalanced so that all of the weight is taken from the working mechanism. The chisel ram has a 17 in. vertical movement and a 16 in. transverse movement across the carriage, and will mortise 6 in. deep. Power is imparted by a train of gearing and reverse friction pulleys, all placed outside for ready inspection and adjustment. The cutting speed of the chisel is 13 ft. per minute, with a return at double this speed.

The table common to both these machines is of steel beam construction, of very rigid character, which will clamp material 20 in. wide by 16 in. thick. It is provided with quick acting eccentric clamps and has both a power and hand feed.

The Bentel & Margedant Co., Hamilton, O., in addition to this combined mortising and boring machine, also have combinations, similarly arranged, of mortising and gaining machines and of gaining and boring machines.



HAMILTON COMBINED HOLLOW CHISEL, MORTISING AND BORING MACHINE.

THE STURTEVANT DUST BLOWING SET.

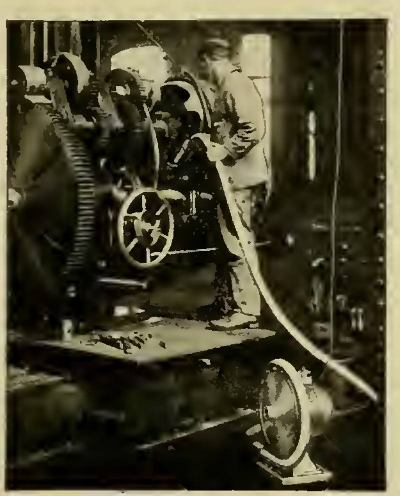
For blowing dirt and dust out from machinery and from around motors, switchboards, shelving, and other places difficult or dangerous of access, the B. F. Sturtevant Company, Hyde Park, Mass., has designed a new portable dust blowing set. The device is electrically driven and weighs only 55 lbs. It is adapted for attachment to lighting sockets, so that the range of its usefulness is very broad.

While the blower does not give as high a pressure as the large compressed air systems, the larger volume of air accomplishes in most cases the same purposes without the hard, severe blast.

There is an additional advantage derived from the larger volume of air in the speed with which the work is accomplished.

The set includes a 12-ft. length of 1¼ in. flexible reinforced air hose and a 10-in. aluminum nozzle. A 20-ft. electric light cord gives a working radius of 32 ft. from a lighting socket.

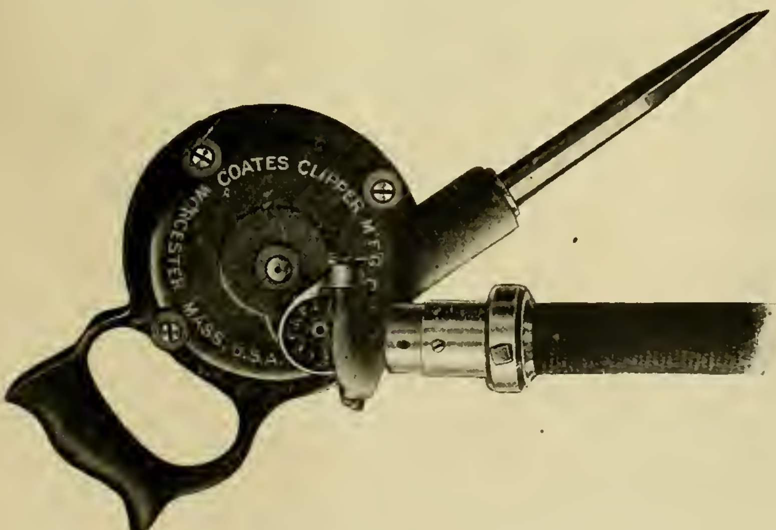
As a vacuum cleaner the set may also be employed for suction cleaning where a dust collector is not necessary. For this work one end of the hose is attached to the inlet of the fan, while the vacuum cleaner tool is attached to the other. The fan will suck the dust through the wheel and discharge it at the outlet or through a hose connected thereto which is led out of doors.



STURTEVANT BLOWER CLEANING LARGE MACHINE TOOL.

MECHANICAL CHIPPING HAMMER.

A chipping hammer which is entirely mechanical in its operation is shown in the illustration. This hammer is operated by a Coates flexible shaft attached to a ½ h.p. motor and strikes a blow equal to a pneumatic hammer. There is not a valve, lever of spring used in connection with it in any way. It has been very carefully tried out on various kinds of work and has given good satisfaction in every case. Riveting heads can be substituted in place of the chisels and the same outfit can be used for riveting.



MECHANICAL CHIPPING HAMMER DRIVEN BY A COATES FLEXIBLE DRIVE.

One of the surprising features of using a hammer of this kind is the cost of operation. The motor being ½ h.p., it is figured out that the actual current consumed per hour in operating the hammer is about 330 watts. At the prevailing price of electric current for power, the cost of operating would be less than 3 cents per kilowatt hour.

This is only one of the recent additions to the already numerous tools and devices made by the Coates Clipper Manufacturing Co., of Worcester, Mass., in which its flexible shaft is employed to transmit the power. This same outfit can be used for drilling, grinding and scratch brushing, preparing rails for bonding, doing repair work on locomotives and similar classes of work.

EXAMPLE OF WORK DONE BY A MECHANICALLY DRIVEN CHIPPING HAMMER.

SASH OPERATING IN SHOP BUILDINGS.

The mechanical control of a few or a hundred pivoted and hinged sash in the modern industrial building is readily accomplished with the "Straight Push" Sash Operator.

This is the latest device of this character to be patented and placed on the market, and is designed to be nearly fool-proof and to open sash under varying conditions without getting out of order. It is manufactured by the G. Drouvé Company, of Bridgeport, Conn.

A sash operating device in shop service must be built to stand handling by many different operators and considerable abuse comes quite naturally. Pivoted windows are not always made to fit their frames without binding and the changes of weather and swelling of the wood often makes the use of a chisel and hammer necessary to open them. The man that comes to operate the sash very seldom takes these facts into consideration and as he gets heated and the device refuses to answer to his efforts, he either gets assistance or his own strength reinforced by an iron bar, this particularly where worm and gear is used, causes something to break, usually the apparatus.

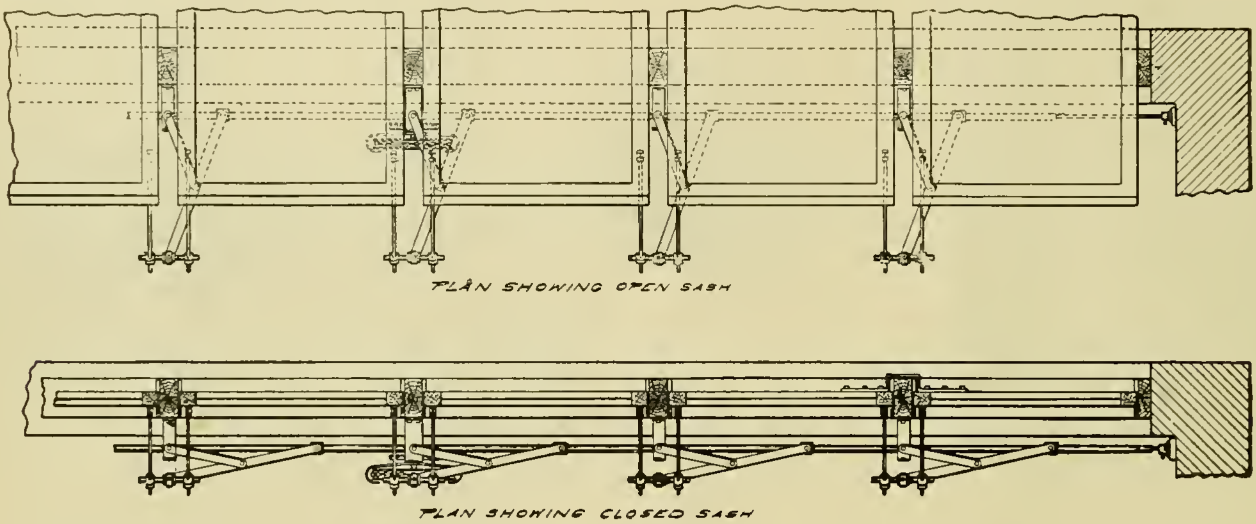
The G. Drouvé Co. have been manufacturing and installing sash operating devices for a number of years and the success with which the "Lovell" push-and-pull type met from the start and its general specification today, with over 400,000 feet in use, has given the company some experience and facts that have been taken advantage of in the design of the new "Straight Push" Operator.

The direct pushing outward of the sash with two half-inch steel rods by leverage, one arm being fastened to each side of the sash at the lower part of side rail insures an opening of the window. These two arms are adjustable to give a 30 deg. or 45 deg. opening.

A line of ¾-inch pipe shaft to which is fastened the main lever at each sash with an open coupling, is moved backwards and forwards between spool roller brackets secured at each interval between windows. A rack and pinion with geared wheel, controlled by a chain from the floor, gives the forward and return movement.

A guide lever is secured to the top of each bracket and in turn is fastened to the main lever. The unattached end of main lever has a U-chair riveted to it which supports the shaft connecting the two steel arms. While the arms bind to the connecting shaft it works freely in the U-chair support, allowing the arms to follow the inclination of the sash.

The movement back or forth of the main shaft operates the levers at each window and as all arms work simultaneously, the arms being directed straight at each side of sash, the windows open or closed as desired—quickly, surely and each window has the same power applied. As no lost motion occurs the farthest window on the line oerates in unison with the first.



"STRAIGHT PUSH" SASH OPERATOR.

Several different sizes of wheels are made which gives the increased power required as the number of sash to be operated is increased. Any number from 10 to 100 or more sash are easily placed under one control with this operator.

The material is heavy and the few connecting couplings are simple and of substantial strength to withstand strain as well as to resist the corrosive effects of gas and acid fumes.

The apparatus is adapted to operate pivoted side or pivoted top-and-bottom sash, hinged-at-the-top or hinged-at-bottom sash. The operating parts which are very few cannot rust together, as the connections are phosphor bronze-to-iron, the same principle being carried out as is applied to pipe unions for steam service. This insures its operation at any time.

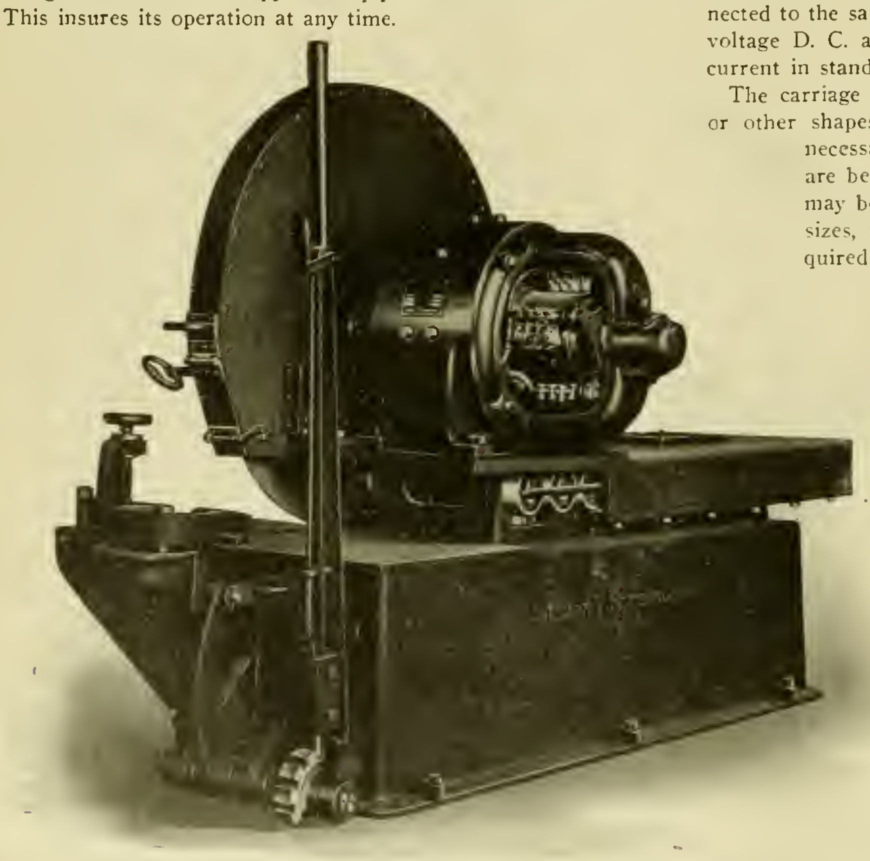
HIGH SPEED FRICTION METAL SAW.

Since metal has entered so extensively into car construction there has arisen a general demand for some method of quickly cutting up steel sections, small bars, etc. Most of the friction saws that have been available have been too large and expensive for this work.

Recognizing this condition, and at the request of a number of railroad mechanical men, Joseph T. Ryerson & Son, Chicago, have designed a high-speed fricton saw which is particularly adapted for this purpose. It is a remarkably simple machine and has a capacity for cutting continuously 15 in., 80 lb., I beams without turning the beam. It will cut such a beam in from 28 to 38 seconds. It needs no special foundation, and requires a floor space of but 7 x 4 ft.

A 52 h.p. motor, that is the result of several years of experimental work by a leading electric company, is direct connected to the saw. These motors are designed for practically any voltage D. C. and for 60 cycle two and three phase alternating current in standard voltages.

The carriage of the machine is arranged so that small beams or other shapes can be cut at an angle. In doing this it is necessary to clamp the work, but when straight cuts are being made no clamping is required. The machine may be used in rapid succession on various shapes and sizes, no change or adjustment of any kind being required



RYERSON HIGH-SPEED FRICTION SAW.

REPACKING JOURNAL BOXES.

The most important feature of the lubrication system consists of the systematic repacking of journal boxes. As cars pass over the repair tracks, or stand on loading, unloading or storage tracks, the old packing should be removed from all of the boxes and re placed with fresh packing. This work should be done at least once a year, and journal boxes should be stenciled with the date the boxes are repacked, so that the work may be continued in a systematic manner. The old packing removed from the journal boxes should be put into a vat of hot oil, and thoroughly washed, and cleansed of all impurities. It should then be thrown upon a screen, and the surplus oil drained off, so that after being shaken out and handled again by hand it is ready for use again. This renovating process removes all the sand, cinders, heavy grease, babbitt, and all foreign matter, from the waste, changing it from a heavy, soggy mass to a light, fluffy condition. This work is all done by a man with a hay fork.

The device I am describing is a hot oil soaking vat, or waste cleaning machine, now in general use on two of the leading railways in the West. It consists simply of a metal vat resting upon, or completely surrounded by, steam or hot water pipes, with the drain pans kept hot by the pipes. Under no circumstances should the steam or hot-water pipes be placed inside of this vat, on account of the heat from the pipes evaporating the lighter parts of the oils. This vat is quite inexpensive.—*William J. Walsh before the New England Railroad Club.*

INTERNATIONAL RAILWAY FUEL ASSOCIATION.

CONVENTION—LA SALLE HOTEL, CHICAGO, MAY 23 TO 26.

The chairmen of the various committees will be glad to have circular letters that have been sent out answered and returned as soon as possible. They are all very busy men and should be given every assistance possible in getting the reports completed at an early date.

The Engineers' Society of Pennsylvania will hold its second annual convention in Harrisburg on June 1st, 2d and 3d. The success attending the convention and exhibit last year was so great as to warrant making special efforts this year to increase the size and scope of both. The exhibit will be held in the new reinforced concrete building of the Central Pennsylvania Tracton Company, Cameron and Forster streets, Harrisburg, where approximately 26,000 square feet of ground floor space is available.

"The Thermal Conductivity of Fire-Clay at High Temperature," by J. K. Clement and W. L. Egy, issued at Bulletin No. 36 of the Engineering Experiment Station, University of Illinois, is a report of the results of experiments on the thermal conductivity of several commercial fire-clays at high temperatures. A detailed description of the instruments and methods of high temperature measurements is included. Copies of the Bulletin may be obtained gratis on application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

More than 60,000 people and institutions own the stock of the Pennsylvania Railroad.

PERSONALS.

P. C. Withrow has been appointed mechanical engineer of the Denver & Rio Grande, with offices at Burnham Station, Colo.

L. O. Jackson has been appointed mechanical superintendent of the Beaumont & Great Northern, with office at Onolaska, Tex.

J. W. Lowery has been appointed master mechanic of the Tombigbee Valley, with office at Calvert, Ala., succeeding F. P. Brooks.

F. H. Neward, master mechanic of the Pontiac, Oxford & Northern (Grand Trunk), with office at Pontiac, Mich., has resigned.

W. J. Bingley succeeds Mr. Tritsch as master mechanic of the Maryland division of the Western Maryland, with office at Hagerstown, Md.

E. W. Pratt, assistant superintendent of motive power and machinery on the Chicago & Northwestern Ry., has been transferred from Chicago to Clinton, Ia.

J. W. Small has been appointed superintendent of machinery of the Kansas City Southern, with office at Pittsburg, Kan., succeeding F. R. Cooper, resigned.

D. M. McKenna has been appointed foreman of the car department of the International & Great Northern, with office at Palestine, Tex., succeeding W. E. Looney, resigned.

H. C. Stevens has been appointed master mechanic of the Fourth division of the Denver & Rio Grande, with office at Alamosa, Colo., succeeding J. H. Farmer, transferred.

W. E. Woodhouse, master mechanic of the Canadian Pacific at Calgary, Alb., has been appointed shop superintendent at Winnipeg, Man., succeeding S. J. Hungerford, resigned.

R. P. C. Sanderson has resigned as superintendent of motive power of the Virginian Railway to become general superintendent of the new plant of the Baldwin Locomotive Works at Eddystone, Pa.

J. H. Farmer, master mechanic on the fourth division of the Denver & Rio Grande at Alamosa, Colo., has been appointed master mechanic of the Rio Grande Southern, with office at Ridgway, Colo.

G. H. Emerson, superintendent of motive power of the Great Northern, at St. Paul, Minn., has been appointed assistant general manager, with office at St. Paul, succeeding H. A. Kennedy, resigned.

C. M. Tritsch, master mechanic of the Maryland division of the Western Maryland at Hagerstown, Md., has been appointed superintendent of motive power and car departments, suceeding R. C. Evans, resigned.

W. H. Wilson, superintendent of motive power of the Buffalo, Rochester & Pittsburgh at DuBois, Pa., has resigned, effective April 1, to enter the service of another company, with headquarters at St. Paul, Minn.

M. K. Barnum, who since July, 1904, has been general inspector of machinery and equipment on the Chicago, Burlington & Quincy R. R., has been appointed general superintendent of motive power of the Illinois Central R. R., with headquarters at Chicago, effective April 1.

The mechanical department of the Great Northern, formerly in charge of G. H. Emerson, has been divided, and two superintendents of motive power have been appointed. R. D. Hawkins, formerly assistant superintendent of motive power, has been appointed superintendent of motive power, with jurisdiction over the mechanical and electrical forces, other than locomotives and car shops, and A. C. Deverell, assistant superintendent of motive power, has been appointed superintendent of motive power, with jurisdiction over locomotives and car shops.

Samuel J. Hungerford has been appointed superintendent of rolling stock of the Canadian Northern, with office at Winnipeg, Man. Mr. Hungerford was born July 16, 1872, at Bedford, Que. He began railway work as a machinist apprentice in May, 1886, with the Southeastern Railway, now a part of the Canadian Pacific, at Farnham, Que. He was then consecutively machinist apprentice, machinist, round-house foreman, locomotive foreman, general foreman, master mechanic and superintendent of locomotive works at Winnipeg. Since January, 1908, he has been superintendent of shops at Winnipeg, which position he resigned to become superintendent of rolling stock of the Canadian Northern and the Duluth, Rainy Lake & Winnipeg, with office at Winnipeg.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

CAR ROOFING.—A circular from H. W. Johns-Manville Company, describes the J-M Car-Best-Us car roofing.

LIFTING MAGNETS.—A leaflet, which by means of a large cross section describes the detail construction of a lifting magnet of large capacity, is being issued by the Cutler-Hammer Clutch Company, Milwaukee, Wis.

BOLT CUTTERS.—A leaflet which illustrates and briefly describes the automatic opening die head now being furnished to bolt cutters, nut tappers and pipe threaders by Wells Bros Co., Greenfield, Mass., is now ready for distribuiton.

VALVES AND FITTINGS.—A 120-page illustrated catalog has just been issued by the Watson-Stillman Co., 50 Church St., New York, which, it is claimed, lists more types and combinations of hydraulic valves and fittings than have ever before been included in a single catalog.

MOTOR DRIVEN AIR COMPRESSORS.—Publication No. 387 of the National Brake & Electric Co., Milwaukee, Wis., is exclusively devoted to a detailed illustrated description of the National motor driven air compressors, which are noticeable for their simplicity, reliability and high efficiency.

SANITARY EQUIPMENT.—A catalog which illustrates the latest design and arrangement of sanitary equipment for shops, including toilet room facilities, metal lockers, steel shelving, work benches, and drawing stands, is being issued by the Manufacturing Equipment & Engineering Company, Boston, Mass.

VANADIUM IN FRENCH AND GERMAN.—The American Vanadium Company, Frick Building, Pittsburgh, Pa., is issuing a completely illustrated catalog descriptive of vanadium products and containing detailed instructions for the use of vanadium under various conditions, in either the French or German language.

TOOL STEELS.—A book being issued by E. S. Jackman & Company, 710 Lake St., Chicago, discusses the features and advantages of the Firth-Sterling tool steels, dealing with water hardened steels exclusively. It includes directions for judging heats by magnets, the proper method of tempering and other similar information.

OIL STORAGE SUGGESTIONS.—A small leaflet is being issued by Gilbert & Barker Mfg. Co., Springfield, Mass., that contains five suggestions in connection with oil storage. Illustrations of typical installations for railways are included. The system manufactured by this company includes underground tanks and self-measuring pumps.

STEAM METERS.—Bulletin No. 4720, recently issued by the General Electric Company, describes in considerable detail, steam and air flow meters. These meters will give an automatic record of the flow of steam, in pounds per hour, through pipes of any diameter and at any temperature, pressure or degree of moisture met in commercial practice.

BELMONT PACKING.—The Clement Restein Co., 133 N. 2nd St., Philadelphia, is issuing general catalog No. 3, comprising 150 pages, that illustrates and describes in a very attractive manner, packing, hose and gaskets to meet practically every conceivable condition. This catalog is one of the most complete that has ever been published on these products

JACKS.—A very interesting and complete catalog, covering 43 pages, is being issued by Fairbanks, Morse & Co. It is numbered 109 B and fully illustrates and describes the Barrett patent compound lever jacks, ball bearing and roller bearing screw jacks, as well as Duff-Bethlehem hydraulic jacks. These are furnished in special designs to suit all railroad uses.

STEAM TURBINES.—Bulletin No. 176 of the Sturtevant engineering series, issued by the B. F. Sturtevant Co., Hyde Park, Mass., deals with the subject of steam turbines for driving ventilating fans, blowers, or generator sets. This company manufactures complete direct-connected units of this character in many sizes. The bulletin illustrates and describes the details of construction.

CAR HEATING.—The perfected thermo-jet system of car heating is very fully described in a catalog being issued by the Safety Car Heating & Lighting Company, 2 Rector St., New York. This company has been most successful in the introduction of this system, which combines a steam and air system below 212 degs. temperature; a vapor system at 212 degs., and a pressure system above 212 degs.

THE PRODUCTS OF KENNICOTT.—A very attractive catalogue, arranged in loose leaf form for future additions that will be issued in the shape of bulletins, has been received from The Kennicott Co., Chicago. It briefly describes the plant, located at Chicago Heights, where this company manufactures its varied line of products, and includes illustrations and descriptions of the Kennicott water weigher that automatically and accurately weighs all water used by boilers or for other purposes.

PORTABLE ELECTRIC TOOLS.—Electric chipping hammers, drills, portable grinders, etc., have been perfected to a point where their reliability and durability are beyond doubt. An attractive catalog which fully illustrates and describes tools of this character in many different sizes and designs is being issued by the Cincinnati Electric Tool Company, 650 Evans St., Cincinnati, O. They are adapted for either direct or alternating current and possess a surprising power when the weight is considered.

TURRET LATHES.—A catalogue which is noticeable for its artistic arrangement and appearance, even in these days of high-grade catalog work, has been received from the Gisholt Machine Company, Madison, Wis. It contains excellent illustrations and clearly expressed descriptive matter on turret lathes, both belt and motor driven. A number of pages are given up to illustrations of the great variety of parts which can be completely finished on these lathes. Several unusual operations are illustrated in detail by photographs.

TRACTIVE EFFORT TABLES.—The March *Bulletin* of the American Locomotive Company considers the tractive effort of simple locomotives and includes very complete tables that give the tractive effort under practically all combinations of steam pressure, wheel diameter and cylinder size. This bulletin is arranged to be self indexing, the tables being on folded insert sheets. It, we believe, contains the only tables of tractive effort that cover large modern locomotives. Tables of piston speeds, speed factor, curves, cylinder volumes, weight of tubes, etc., are included.

DIRECT CURRENT MOTORS.—Bulletin No. 119, from the Fort Wayne Electric Works, Fort Wayne, Ind., briefly considers the Northern type B direct current motors, that are specially adapted for application to machine tools.

GLYCO METAL.—An 80-page, thoroughly illustrated booklet, that should be in the hands of every user of bearing metal, is being issued by Joseph T. Ryerson & Son, Chicago. Part of the book is given up to a discussion of the invention, function, properties, manufacture and application of Glyco metal; following which there is given the data on its performance in actual practice and tests, and description of the various grades. At the end of the book there are about twenty pages of the most valuable and interesting information on such subjects as the laws of friction; physical characteristics of lubricants; crank pin calculations; length of shaft bearings; specific gravity of an alloy; melting point of various substances, and admissible loads on bearings.

NOTES

BROWN HOISTING MACHINERY CO.—Fayette Brown, president, died on January 20. Mr. Brown was 87 years of age.

S. OBERMAYER CO.—Harry Hoover, a former well known foundry foreman, has been appointed the agent of this company in Buffalo and Dunkirk, N. Y.

ROBINS CONVEYOR BELT CO.—The executive, sales, engineering and purchasing departments of this company have been installed on the 26th and 27th floors of the Park Row building, New York. The branch office at 30 Church street will be discontinued.

WALTER B. SNOW, publicity engineer, announces that his office facilities have been more than doubled by removal to rooms 421 to 425, inclusive, 170 Summer street, Boston, Mass. Benjamin Baker, formerly of the Boston *Transcript*, and Herbert M. Wilcox, chemical engineer, have been added to his staff.

JOHNS-MANVILLE CO.—Both the Chicago and Baltimore branches of this company have outgrown their quarters and on March 1 the Chicago branch moved to 27 Michigan avenue, in the block between S. Water and River streets, where 32,500 square feet of floor space is available. The Baltimore office is now located at 30 Light street, where much larger quarters have been obtained. Both offices will keep on hand a large stock of J-M products and will be in a better position than ever to give prompt shipments.

KELLER MFG CO.—At the annual meeting of the Board of Directors in Philadelphia, the following officers were elected: Julius Keller, president; W. P. Pressinger, William H. Keller and S. W. Prince, vice-presidents; Frances J. Rue, treasurer, and C. S. Bell, secretary. This company has purchased the business of the W. P. Pressinger Company, of New York, and J. J. Swan, secretary of that company will now be associated with the Keller Co. It is also announced that Charles Strader has been placed in charge of the western branch, with offices in Chicago and Lincoln, Neb.

CHARLES F. AARON, general sales manager of the New York Leather Belting Company, died at his country home, Plainfield, N. J., on March 4. Mr. Aaron was probably the best known belting salesman in the United States for many years. He has been very prominent in various American machinery manufacturers associations and was president of the American Supply and Machinery Association. He has for a long time been waging a campaign, both personally and in this association, for raising to a higher plane the standards of manufacture of leather belting, and has had remarkable success in this direction. He was but 43 years old at the time of his death.

AN EFFICIENT FUEL DEPARTMENT.

A DESCRIPTION OF THE ORGANIZATION, METHODS OF ACCOUNTING AND OPERATION OF THE FUEL DEPARTMENT OF THE ATCHISON, TOPEKA & SANTA FE RAILWAY, WHICH HAS SHOWN REMARKABLE RESULTS NOT ONLY IN THE REDUCTION IN THE FUEL CONSUMPTION, BUT ALSO INDIRECTLY IN IMPROVING THE CONDITION OF THE MOTIVE POWER.

On the Atchison, Topeka & Santa Fe Railway System the locomotive and other fuel, from the time it is delivered by the mining comany to the time it is loaded on to the locomotive tenders. or put into the various coal bins, with the exception of the time it is actually in transit, is under the control of the general storekeeper, who handles it through a specially organized fuel department. The same thing applies to fuel oil, which is very extensively used on this road, and the features and forms explained in this article as applying to coal are also arranged to apply in exactly the same manner to fuel oil.

The organization of the fuel department is very simple and consists of a chief fuel supervisor, whose office is located adjacent to the general storekeeper at Topeka; a number of fuel inspectors, who are continually traveling over the system under the direction of the fuel supervisor; the foremen at the various fueling stations, who report direct to the supervisor, and the inspectors at the various mines, who inspect the coal delivered and weigh the cars. In addition there are several clerks and stenographers in the supervisor's office for maintaining the records, etc.

It is largely due to the system of accounting that the excellent results obtained have been possible. The forms used are such as will give accurate and detailed information concerning the fuel received at each station, the amount delivered to each locomotive, the time it was delivered, the length of time this locomotive was on the road, the tonnage hauled, the weather conditions and the name of the engineer and fireman. These reports are received daily and permit the immediate discovery of any unusual fuel consumption resulting in the immediate investigation of the reasons leading to it and the correction of the fault.

Starting at the mine—The coal is contracted for by the purchasing agent and is loaded and weighed under the supervision of one of the fuel department inspectors, who has the authority to refuse it unless the coal, in his opinion, is of the proper quality. These cars are then delivered to the station agent at this point, who fills in form 1281 in triplicate, one copy being sent to the mine as a receipt, the second to the fuel supervisor for his records and the third to the purchasing agent, who immediately pays the mining company for the coal upon the basis of this invoice.

The coal is then in what is known as "Stock A" and is held as an asset by the fuel department. The cars are forwarded by the station agent at the mine in accordance with the direction of the division superintendents, each mine furnishing certain particular divisions. The superintendents of these divisions each day notify this agent of the amount of coal they will require on the following day.

Form 1281, as will be seen by reference to the illustration, contains the way-bill number, the car initial and number, its destination, weight in pounds, and kind of coal. The last two columns of the form are not filled in by the forwarding agent but are completed in the supervisor's office from the information that is furnished by form 1284 which acts as a check in accounting for all cars that were reported as sent out from the mines.

At all fueling stations the foremen fill out and mail daily a copy of form 1284. This is made in duplicate, the copy being retained. As will be seen by reference to the illustration, this form contains the way-bill number and date on which each car was received, and must check with the same information on form 1281. The complete instructions on the back of this form explain its use clearly and are as follows:

1. A report on this form must be rendered daily by Agents or Fuel Foremen at Fuel Stations as follows:

On A. T. & S. F. Ry., Coast Lines, Original of Front Page to Auditor and carbon copy of Front Page and Original of Back Page to Fuel Supervisor.

On G. C. & S. F. Ry., Original of Front Page to Auditor and carbon copy of Front Page and Original of Back Page to Fuel Supervisor.

On A. T. & S. F. Ry., only one copy to be made, which must be mailed to Chief Fuel Supervisor daily.

The copy of report for Fuel Supervisors to be made complete on one sheet. No carbon copy need be made of back page.

2. All fuel unloaded and used at station must be reported as received and unloaded on this form, giving complete way-bill reference. The billed weights shown on way-bills should in all cases be used; scale weights on coal from mine to be ignored.

3. Cars of fuel received at stations and held for disposition, are not to be reported on this form until unloaded or rebilled to other than regular Fuel Stations. When diverted to regular Fuel Stations, they must move under original way-bills, which are not to be taken into account until fuel reaches final destination and is unloaded. When forwarded to other than regular Fuel Stations, cars should be reported on this form and weights shown in column "For other purposes," way-bill taken into account and new billing issued and reference shown in column "Coal forwarded."

4. Stations at which there are no chutes will have to report coal received for locomotive purposes in No. 2 "Chutes" column.

Form 1281 Standard.

Santa Fe.

(Insert name of Railway Company.)

DAILY REPORT OF COMPANY "STOCK A" COAL FORWARDED

From ______ Station ______ 190__

Way-Bill No.	Way-Bill Date	Destination	Car Initial	Car Number	Weight in Lbs.	Kind of Coal	Invoice No.	Reported By Station	Reported By Date

FORM 1281 IS FILLED IN BY THE AGENT AT THE SHIPPING POINT, A COPY BEING FORWARDED TO THE PURCHASING AGENT, FUEL SUPERVISOR, AND THE MINING COMPANY. THE PURCHASING AGENT PAYS FOR THE COAL AT ONCE ON THE BASIS OF THIS REPORT.

Ha 700 5M 1941

Form 1284 Standard.

Santa Fe.

DAILY FUEL REPORT *from*________________*Station.* *For*________________*190*___

SEE COMPLETE INSTRUCTIONS ON BACK OF THIS FORM.

DEBITS

COAL RECEIVED AND UNLOADED									WOOD RECEIVED
WAY-BILL		FROM	CAR NUMBER	(1) LBS IN CHUTES FROM MINES	(2) Lbs in Chutes from other Stations and from Storage	(3) LBS. UNLOADED IN STORAGE	(4) POUNDS FOR OTHER PURPOSES		CORDS
NUMBER	DATE								
		(5) CHUTE DROPPINGS							
		CAR No	POUNDS						
		Total Receipts,							

CREDITS

COAL FORWARDED				ISSUES		
WAY-BILL NUMBER	CAR NUMBER	DESTINATION	WEIGHT	TO	COAL POUNDS	WOOD CORDS
				Section Houses 0		
				Pile Driver—Track 0		
				Pile Driver—Bridge 0		
				Bridge Watch House 0		
				Sta. Eng's for Heat and Power for Shops S. E.		
				Roundhouses 81		
				Superintendents' Offices 61		
				LOCOMOTIVES *Passenger* 82		
				LOCOMOTIVES *Freight* 82		
				LOCOMOTIVES *Mixed* 82		
				LOCOMOTIVES *Switch* 73		
				Water Supply 83		
				Sand Houses 85		
				Cars—Passenger 89		
Total,				*Cars—Freight* 89		
				Stations—Passenger 88		
COAL SOLD.				*Stations—Freight* 66		
AUTHORITY	CAR NUMBER	TO WHOM	WEIGHT	*Stations—Common* 06		
				Eating Houses 60		
				Reading Rooms 89		
				Clearing Wrecks 93		
				Clearing Wrecks 93		
				Total Issues,		
				Total Sold,		
				Total Forwarded,		
				Total Credits,		

1. SHOW POUNDS UNLOADED IN CHUTES FROM CARS RECEIVED ON ORIGINAL BILLING FROM MINES.
2. SHOW POUNDS UNLOADED IN CHUTES FROM CARS RECEIVED FROM OTHER STATIONS OR TAKEN FROM STORAGE.
3. SHOW POUNDS UNLOADED IN STORAGE. WHEN COAL IS TAKEN FROM STORAGE, SHOW POUNDS IN RED.
4. SHOW POUNDS FOR CARS WHICH ARE FORWARDED TO OTHER STATIONS OR USED FOR OTHER THAN LOCOMOTIVES.
5. SHOW CHUTE DROPPINGS WHICH ARE PUT IN CHUTES, OR, IF FORWARDED, SHOW UNDER No. 5 AND ALSO UNDER COAL FORWARDED.

THE FACE OF FORM 1284. THIS FORM IS FILLED IN AND FORWARDED DAILY FROM EACH OF THE COALING STATIONS. IT GIVES A COMPLETE DAILY BALANCE OF THE OPERATION OF EACH STATION, SHOWING IN DETAIL THE COAL RECEIVED AND ISSUED. THE BACK OF THE SHEET IS SHOWN IN ANOTHER ILLUSTRATION.

Rail 8 09 25M 14299

Form 814 Standard

Santa Fe.

(Insert name of Railway.)

.... Division.

DAILY TRAIN TALLY SHEET, AND TRAIN DISPATCHER'S REPORT OF TRAIN TONNAGE AND FUEL CONSUMPTION PER 100 TONS MILES IN ________ SERVICE. DATE ________ 19__

Train No.	Kind Train	CONDUCTOR	ENGINEER (Initials and name in full)	FIREMAN (Initials and name in full)	Engine No.	From	To	Actual Train Miles	Time Called	Time Left	Time Arrived	Total Time in Service Hrs.	Total Time in Service Min.	No. of Stops	TONNAGE LEAVING						NOT TO BE FILLED IN BY TRAIN DISPATCHER: Ton Miles	Coal or Oil Consumed	Average Tons per Train	Average Pounds of Coal or Oil per 100 Ton Miles	REMARKS If Light Engine show reason for running, etc.

NOTE. { Be very careful to enter but one engine on a line.
Be very careful to show run of each engine outside of yard limits, including double-headers, helping and light engines, and engines doubling hills (both up and down).
In "Kind of Train" column state if train was freight, passenger, mixed, special work, construction, light engine, engine helping passenger train or engine helping freight train.
When work train runs some distance and then works between two points, be careful to show movement running and movement working, separately, giving time starting and stopping in each item.

This sheet to be made up in manifold in Train Dispatcher's office daily, and forwarded without delay as follows:

For The A. T. & S. F. Ry. to { Ticket Auditor, Topeka. Car Accountant, Topeka. Three copies to Fuel Supervisor, Topeka.
" G. C. & S. F. Ry to { General Supt., Galveston. Auditor, Galveston. Three copies to Fuel Supervisor, Cleburne.
" A. T. & S. F. Ry., Coast Lines, to { Car Accountant, Los Angeles. Auditor, Los Angeles. Three copies to Fuel Supervisor, San Bernardino.
" E. Ry. of N. M. System and S. K. Ry. Co. of Tex., to Auditor, Amarillo.

Conductors are instructed to date their Train reports the day on which the train leaves, and the object of this sheet being to correct Conductor's reports, it is important that all TRAINS leaving Division stations before 12 o'clock, midnight, should be included.

In giving time when trains leave and arrive, be careful to say whether it is "A. M." or "P. M.," as in tracing cars of time freight it is necessary to know the exact time of arrival and departure of trains.

Construction and work trains are to be included in this sheet, showing between what stations they are at work.

All light engines must be shown, and in column of "Remarks" reason for movement entered, as "To even power," "Pusher returning to proper position," etc.

Reason for any unusual delays to trains must also be shown.

Make separate report for passenger and freight service.

Weather Conditions...

.... *Chief Train Dispatcher.*

MSAACo 10-09-2M-1339-1

FORM 814 IS USED BY THE DISPATCHERS THROUGHOUT THE SYSTEM. THE LAST FIVE COLUMNS ARE FILLED IN BY THE FUEL DEPARTMENT. A COPY OF THIS SHEET IS RECEIVED DAILY FROM EVERY TERMINAL ON THE SYSTEM.

5. Special debit must be taken in proper column for all chute droppings picked up at station.

6. When storage coal is picked up and unloaded in chutes, the car number must be shown and pounds thus transferred reported in "Chutes" column in black ink, and credit allowed opposite in "Storage" column in red ink. When storage coal is forwarded to other stations, credit allowed should be in "Storage" column in red ink.

7. Column "Pounds for other purposes" is to be used for reporting coal received and used for other than locomotives and such as is forwarded to other than regular Fuel Stations.

8. Fuel tickets must be obtained for all issues of coal and wood to locomotives; these are to be listed on back of this report in space provided, and balance with total issues to locomotives shown on face of report for which credit is taken. Fuel furnished to helper and light locomotives should be charged to class of service assigned; fuel for locomotives in Work Service to be charged to "Freight."

Fuel furnished locomotives at end of trip must always be charged to the class af service just completed.

When no ticket is obtained, the issue should nevertheless be charged to the engineman and locomotive taking the coal.

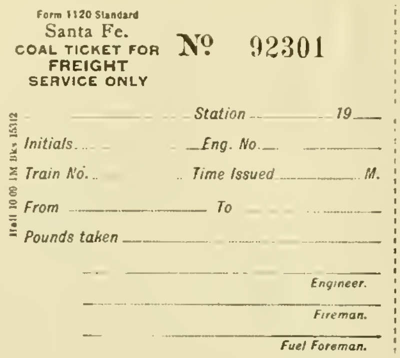
9. Slack coal from mine for stationary engines must not be reported on this form or shown as issued. Nor other coal which is consigned to and used by the Mechanical Department.

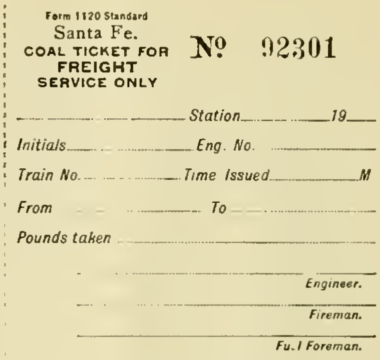
Form 1284 is sent in daily to the fuel supervisor and is accompanied by the fuel tickets on form 1120 (see illustration). These tickets are listed in the spaces on the back of 1284, which table forms the complete report of the amount of coal issued each day at each station, the name of the engineer and fireman who brought the locomotive in, the engine number and the class of service in which it was used. On the face of the form are recorded the coal issued for other purposes. In this manner a complete daily balance showing the condition in each station is obtained.

When a locomotive is put into service its tender is filled with coal, and from that time on whatever coal is required to again fill the tender is charged to the service in which the locomotive has been engaged. For instanc, if a locomotive is fired up in the roundhouse and held for some time, using considerable coal, when it starts out to take a train the tender is filled and the amount taken is charged to roundhouse use. In fact, in every case a locomotive starting from the terminal with a train has a full tender, the amount required to fill it being charged to roundhouse use, inasmuch as it went into the house with a full tender. At the end of the run it again goes to the coal chute and the engineer delivers to the fuel foreman a copy of form 1130, which gives the record of the engine and train number, the service in which it has been engaged and the amount of coal the engineer *estimates* will be required to fill the tender. This is signed with the engineer's and fireman's name, and while it is not forwarded to headquarters, it is kept by the fuel foreman as a check.

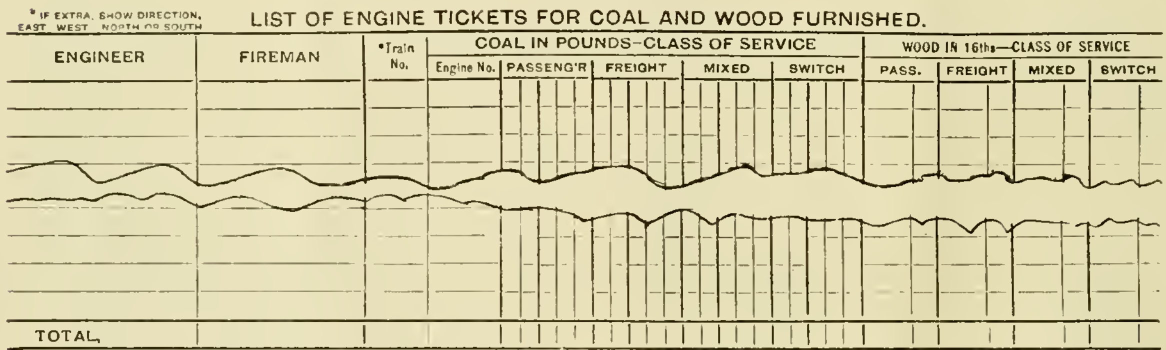
After the coal is actually delivered to the locomotive and the amount is accurately known, form 1120, which is in triplicate and arranged to fold in such a way as to permit the use of carbon paper for making all three copies at one time, is filled out by the fuel foreman. This contains in addition to the information contained on form 1130, the actual amount of coal taken and the fuel foreman's signature. One copy of this form is forwarded daily with form 1284, previously mentioned, one copy is given to the engineer and the third copy is retained by the fuel foreman.

Form 1120 is made in four colors, the white being for locomotives in freight service; the red for passenger service; the yellow for switching service and the blue for mixed or work train service.


Form 1120 Standard
Santa Fe.
COAL TICKET FOR FREIGHT SERVICE ONLY
№ 92301
Station 19
Initials Eng. No.
Train No. Time Issued M.
From To
Pounds taken
Engineer.
Fireman.
Fuel Foreman.


Form 1120 Standard
Santa Fe.
COAL TICKET FOR FREIGHT SERVICE ONLY
№ 92301
Station 19
Initials Eng. No.
Train No. Time Issued M
From To
Pounds taken
Engineer.
Fireman.
Fuel Foreman.

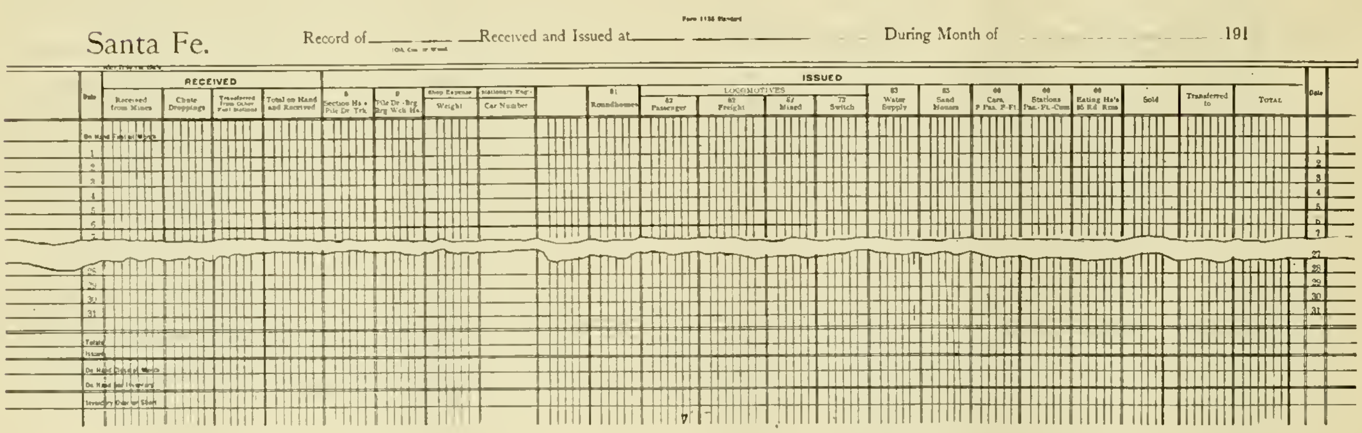
FORM 1120 IS FILLED IN BY THE FUEL FOREMAN WHENEVER A LOCOMOTIVE TAKES COAL. THE BLANK SPACE IN THE CENTRE IS A DUPLICATE OF THE OTHER FORMS, BEING PRINTED ON THE BACK OF THE SHEET, SO THAT WHEN FOLDED TWO CARBON PAPERS WILL MAKE THREE COPIES. ONE COPY IS SENT TO THE FUEL DEPARTMENT HEADQUARTERS DAILY WITH FORM 1284, ONE IS DELIVERED TO THE ENGINEMAN AS A RECEIPT, AND THE THIRD IS RETAINED FOR A RECORD.


* IF EXTRA, SHOW DIRECTION, EAST, WEST, NORTH OR SOUTH

LIST OF ENGINE TICKETS FOR COAL AND WOOD FURNISHED.

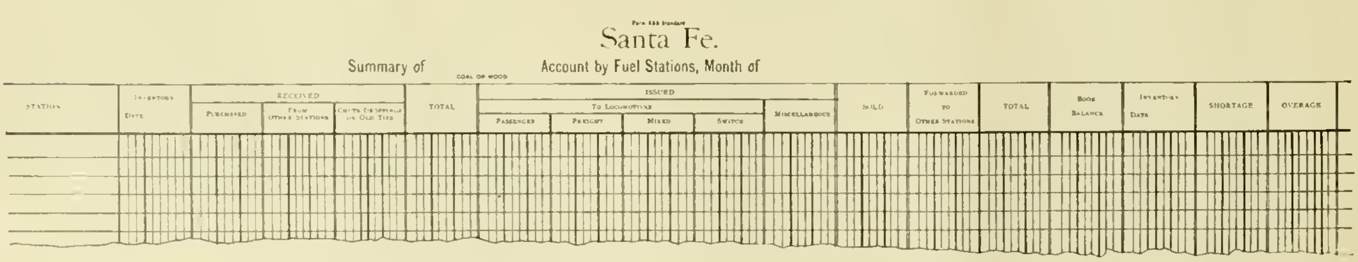
ENGINEER	FIREMAN	*Train No.	COAL IN POUNDS—CLASS OF SERVICE					WOOD IN 16ths—CLASS OF SERVICE			
			Engine No.	PASSENG'R	FREIGHT	MIXED	SWITCH	PASS.	FREIGHT	MIXED	SWITCH
TOTAL											

BACK OF FORM 1284 SHOWING THE ARRANGEMENT FOR LISTING THE COAL ISSUED AT EACH STATION. THIS INFORMATION IS COPIED FROM FORM 1120, WHICH ARE SENT IN DAILY WITH THIS REPORT. THE FACE OF THE FORM IS SHOWN IN ONE OF THE OTHER ILLUSTRATIONS.


Form 1135 Standard
Santa Fe. Record of ______ Received and Issued at ______ During Month of ______ 191

RECEIVED: Received from Mines; Chute Droppings; Transferred from Other Fuel Stations; Total on Hand and Received
ISSUED: Roundhouses; LOCOMOTIVES: Passenger, Freight, Mixed, Switch; Water Supply; Sand Houses; Cars; Stations; Eating Ho's; Sold; Transferred to; TOTAL
Date: 1–7 … 27–31; Totals; Issued; On Hand

FORM 1135 IS MAINTAINED IN THE FUEL DEPARTMENT OFFICE, BEING FILLED IN FROM THE REPORT ON FORM 1284. THE FIGURES AT THE HEAD OF EACH ITEM REFER TO THE INTERSTATE COMMERCE COMMISSION CLASSIFICATION.


Form 533 Standard
Santa Fe.
Summary of ______ Account by Fuel Stations, Month of ______

STATION	INVENTORY DATE	RECEIVED: PURCHASED	FROM OTHER STATIONS	CHUTE DROPPINGS OR OLD TIES	TOTAL	ISSUED TO LOCOMOTIVES: PASSENGER	FREIGHT	MIXED	SWITCH	MISCELLANEOUS	SOLD	FORWARDED TO OTHER STATIONS	TOTAL	BOOK BALANCE	INVENTORY DATA	SHORTAGE	OVERAGE

FORM 533 WHICH GIVES A MONTHLY SUMMARY OF ACCOUNTS FOR EACH OF THE FUEL STATIONS. IT IS FILLED IN FROM THE REPORTS ON FORM 1135 AND PERMITS THE CONDITION OF THE WHOLE SYSTEM TO BE EVIDENT AT A GLANCE.

The most important feature of this system is the daily train tally sheet, form 814, which is the supporting base on which the system is founded. From it is compiled the various reports carrying information that has assisted so materially in reducing the consumption of fuel. This form is simply an enlargement of the ordinary tally sheet in use by practically all railroads. As originally printed, it was made in the trainmaster's office from the train sheets and copies sent to the ticket auditor, car accountant, superintendent and master mechanic, and as printed to-day it is compiled as formerly by the trainmaster; additional information in way of tonnage handled in trains between stations being entered by that office and an extra copy to that formerly sent to the superintendent and master mechanic, being sent to the fuel department. On receipt the fuel department inserts the ton-miles as well as the pounds of fuel consumed by each engine and crew and the average train haul, also the consumption of fuel per 100 ton-miles. Each trip is closely observed and excess consumption noted, and in returning the form to the superintendent his attention is called to all excessive consumption of fuel

Form 1130 Standard

SERVICE TICKET—FUEL Santa Fe.

Station .... 190 ..

Engine Train .... Service ....

From To ....

ESTIMATED Amount of }
Coal Required to Fill Tank } .... lbs.

.... Engineer

.... Fireman

MS&ACo-3-09-100M-12181

FORM 1130 IS FILLED IN, SIGNED AND DELIVERED TO THE FUEL FOREMAN BY THE LOCOMOTIVE ENGINEER WHEN HE ARRIVES AT THE COALING STATION AND DESIRES TO TAKE ON COAL.

caused by delays in getting over the road, while in sending the form to the master mechanic, if the fault is with the crew or from apparent difficulties in the engine, his attention is called to it by a special letter. These reports are compiled in the fuel office and sent out not later than five days after the trip is completed

This tally sheet acts as a check on 1284, and if any train is shown on the dispatcher's sheet and no corresponding record appears on the fuel foreman's report, it immediately shows that there has been a mistake made or the presence of laxness at this point. It is also possible from this sheet to immediately check up any unusual fuel consumption in any service and in fact it permits the immediate location of any error or unusual circumstance anywhere on the system.

Form 1135 is kept in the fuel supervisor's office, there being one sheet for each coaling station, and is arranged to form a monthly record of that station. It is filled in from form 1284 daily and gives the receipts and issues of each station in detail. The numbers appearing in the different columns refer to the Interstate Commerce Commission classification. It will be noted that at the bottom of the sheet are headings showing the amount of coal on hand at the end of the month, as indicated by the totals on the sheet and the heading "On Hand Per Inventory." This inventory is made monthly on form 1283 (see illustration), which will explain itself. It is very carefully filled out by the fuel foreman and the amounts will probably differ somewhat from those shown by the totals on form 1135, due to shrinkage, chute droppings, errors in estimates, weighing, etc. It, however, is entered on 1135, and the difference in the amount shown by the inventory and the amount shown by the record of the month is entered in the proper column. This difference is corrected monthly by a readjustment of the price, never by the amount of coal on hand. Form 1135 for the next month's service is started with the amount of coal on hand as shown by the inventory and no attempt is made to alter these figures to take care of the errors in the report; these differences, as just stated, being taken care of in the price charged the motive power department for the coal.

The chute droppings are periodically picked up and loaded upon a car and are received by the coaling station the same as coal coming from the mine. They are never simply returned to the bins and counted as profit. Thus the total amount of coal which leaves the chute is charged up to the engine being coaled, which influences the engine crew to be very careful not to overload their tenders, or to allow coal to fall upon the ground.

Form 533 is filled in from the totals of 1135 and gives a monthly report of the whole system. It will be seen that the informa-

Form 1283 Standard

Santa Fe.

Monthly Inventory of Coal and Wood on Hand at .... Station, ... 19 ..

POUNDS OF COAL				CORDS OF WOOD		
* 1	IN CHUTES	IN BINS (INCLUDES STORAGE)	TOTAL POUNDS	OLD TIES	FOUR FOOT WOOD	TOTAL No. OF CORDS

* Show cars of coal on hand which have NOT BEEN UNLOADED, and which have NOT BEEN REPORTED ON FORM 1284, on BACK of this report. If through error cars are reported on Form 1284 before being unloaded, include with inventory by showing Car Number in column No. 1 and show number of pounds in column "In Chutes".

.... Foreman.

THE FACE OF FORM 1283 ON WHICH THE MONTHLY INVENTORY, AT EACH FUELING STATION, IS MADE. THE BACK OF THIS FORM IS SHOWN IN ANOTHER ILLUSTRATION.

tion on this is practically the same as that on the monthly balance sheet of the department for the whole system and the original is sent to the auditor, a copy to the vice-president in charge of purchases, and a copy is retained.

The distribution of the fuel which is shown on form 564 is made up from forms 533 and 1135, and is furnished monthly for the information of the auditing department and is used for charging out from "Stock A" fuel accounts direct to the different operating accounts.

Form 1132 is compiled from form 814, which process consists of segregating the various engineers, firemen and engines on individual sheets according to the various classes of engines, etc., thus enabling the department to obtain the individual performance of each.

Form 1133A is filled in from 1132, and includes columns for

Form 1283 Standard

Santa Fe.

MONTHLY INVENTORY

OF

COAL AND WOOD ON HAND

At .... Station

On .... , 19 ..

INSTRUCTIONS.

This inventory must be made on the last day of each month after close of business, and sent in with the regular Daily Report. Daily Report for the first day of each month must begin with the quantities of Coal and Wood on hand, as shown by Inventory of Coal and Wood on hand on last day of preceding month.

Keep a separate account of Coal in storage, and when Coal is loaded therefrom and forwarded to another station, or used in chutes, see that proper credit is shown on Form 1284, in Storage column.

Coal on hand in cars which HAS NOT BEEN REPORTED ON FORM 1284 per Rule 3 shown on that form

WAY-BILL		FROM	CAR		POUNDS
No.	DATE		NUMBER	INITIAL	

BACK OF FORM 1283 SHOWING THE INSTRUCTIONS FOR MAKING THE MONTHLY INVENTORY AND CONTAINING SPACE FOR REPORTING THE CARS WHICH HAVE ARRIVED AT THE COALING STATION BUT HAVE NOT YET BEEN UNLOADED AND HENCE NOT YET REPORTED ON FORM 1284. THE FACE OF THE FORM IS SHOWN IN ONE OF THE OTHER ILLUSTRATIONS.

Santa Fe.

____
(Insert name of Railway Company.)

________________ *Division,* __________ *Line.*
(Insert Main or Branch)

DISTRIBUTION OF FUEL *for Month of* ________________ 190__

ACCOUNTS	ISSUED TO	COAL	WOOD	FUEL OIL	AMOUNT	
		TONS	CORDS	TONS	COAL AND OIL	WOOD
8	Pile Drivers, etc.					
9	" "					
9	Bridge Watch Houses.					
61	Superintendents' Offices.					
66	Stations, Freight.					
	" Passenger.					
	" Common.					
68	Eating Houses.					
70	Yard Offices.					
73	Locomotives, Yard					
82	" Road					
88	Water Supply.					
89	Fuel for Cars, Freight.					
	" " Passenger.					
	" " Common.					
89	Reading Rooms.					
93	Clearing Wrecks, Freight.					
	Passenger.					
	" " Common.					
108	General Offices.					
"Operations of Gravel Pits"	Location.					
"Shop Expenses"						
"Treating Plants"	Location.					
	Total Issued.					
	Disbursements Recollectible (As per Statement Attached).					
	Total Issued and Sold.					

This distribution must be accompanied by a schedule of the bills made to cover the charge to "Disbursements Recollectible," giving the amount of each, and against whom rendered.

________________ 190 ___ ____________________

FORM 564, ON WHICH IS SHOWN THE MONTHLY DISTRIBUTION OF THE FUEL IN ANY PARTICULAR STATION. THIS IS FILLED IN FROM THE INFORMATION ON FORMS 533 AND 1135. THE ORIGINAL OF THIS FORM IS FORWARDED TO THE AUDITOR AND A COPY IS RETAINED IN THE FUEL DEPARTMENT OFFICE.

Santa Fe.

________________ DISTRICT. ________________ DIVISION.

Engineer ________________ ________________ 19 __

Date	TRAIN No.	FIREMAN	ENGINE No.	STATION		TRAIN MILES		TOTAL TIME		No. of Stops	TON MILES		COAL OR OIL CONSUMED	REMARKS
				From	To	East	West	Hrs.	Min.		East	West		

FORM 1132 WHICH IS FILLED IN FROM THE DISPATCHER'S TALLY SHEET AFTER IT HAS BEEN COMPLETED IN THE FUEL SUPERVISOR'S OFFICE. IT GIVES THE INDIVIDUAL PERFORMANCE OF ANY ENGINEER OR FIREMAN, AND CAN ALSO BE USED FOR ANY INDIVIDUAL LOCOMOTIVE. THESE COPIES ARE USUALLY FOR THE FUEL DEPARTMENT INFORMATION ONLY.

Form 1133-A Standard

Santa Fe.

(Insert Name of Railway Company)

FUEL PERFORMANCE OF ____________

____________ DIVISION MONTH OF ____________ 19__

	TOTAL ENGINE MILES		TOTAL TON MILES		POUNDS OF COAL OR OIL CONSUMED		AVERAGE POUNDS OF COAL OR OIL PER 100 TON MILES		AVERAGE TONS HAULED PER TRAIN	ACTUAL COST OF FUEL CONSUMED		COST OF FUEL BASED ON DIVISION AVERAGE		TOTAL MONEY LOSS OR GAIN BASED UPON AVERAGE COST PER TON MILE			
														LOSS		GAIN	

FORM 1133A. THE INFORMATION IS FILLED IN FROM FORM 1132 AND THE ITEMS CONCERNING COST ARE COMPUTED AND INSERTED. THIS FORM IS FOR FUEL DEPARTMENT INFORMATION ONLY, BUT IS VERY LARGELY TRANSFERRED TO FORM 1133, WHICH IS SHOWN IN ONE OF THE OTHER ILLUSTRATIONS

the money value of the fuel consumed by the locomotives under the charge of each engineer. The column headed "Actual Cost of Fuel Consumed" is the product of the number of tons actually used by this engineer and the average monthly cost for that station. This cost being the price charged by the fuel department to the motive power department, and includes all of the cost of handling as well as the expenses of the fuel department. The next column headed "Cost of Fuel Based on Division Average" is the same value per ton multiplied by the average number of tons used by the locomotives on this division engaged in the same service, the ton mileage being the basis. The following two columns then show the loss or gain of this engineer as compared with the average.

Form 1136 Standard

Santa Fe.

Comparative Statement Showing the Tonnage and Fuel Consumption Each Day on Train

No.______ between ____________ and ____________

____________ Division, Month of ____________ 190__

DATE	ENGINEER	ENGINE No	ACTUAL TRAIN MILES	TOTAL TIME IN SERVICE		TON MILES			POUNDS OF FUEL CONSUMED			AVERAGE TONS PER TRAIN	AVERAGE LBS. OF FUEL PER 100 TON MILES	
1														
2														
3														
4														
28														
29														
30														
31														
TOTAL														

FORM 1136 ON WHICH A MONTHLY RECORD OF ANY PARTICULAR TRAIN CAN BE RECORDED.

Form 1133 contains the same headings as 1133A, with the exception of the actual cost of fuel consumed and the cost based on the division average, this sheet showing simply the loss and gain. It is printed on oiled paper and from it are made blue prints which are forwarded to all terminals where they are placed upon the bulletin board. Copies are sent to the superintendents of motive power, master mechanics, road foremen of engines and any one else concerned with the fuel record.

A form is also provided which will permit a comparative statement of the fuel consumption on any particular train during the month. This is numbered 1136 and is taken from the train dispatcher's tally sheet after it has been filled in by the fuel department.

COALING STATIONS.

It will be readily seen that the value of all these records and information concerning fuel consumption depends largely upon the accurate and prompt reporting of the amount of coal actually placed upon each locomotive. All of the old style so called "Trestle of Gravity Chutes" on the line were repaired and pockets calibrated according to the cubic contents of a ton of coal and great care exercised by fuel foreman to see that each issue was properly measured. It was quickly found, however, that what was required was a chute which would give within very narrow limits exactly the amount of coal put on each tender. This, of course, can best be done by actual weighing and it was decided by the management that all of the coal stations built in the future would be of the so-called "Mechanical Type." These chutes all have weighing hoppers which gives, by the balancing of a scale beam, exactly the amount of coal taken.

Hall 1 10 1M 16304

Form 1133 Standard

Santa Fe.

(Insert name of Railway Company)

FUEL PERFORMANCE OF ENGINES, ENGINEERS OR FIREMEN.

____________ DIVISION MONTH OF ____________ 19__

	TOTAL ENGINE MILES	TOTAL TON MILES	POUNDS OF COAL OR OIL CONSUMED	AVERAGE POUNDS OF COAL OR OIL PER 100 TON MILES	AVERAGE TONS HAULED PER TRAIN	TOTAL MONEY LOSS OR GAIN DUE TO PERFORMANCE SHOWN, BASED UPON AVERAGE COST PER TON MILE			
						LOSS		GAIN	

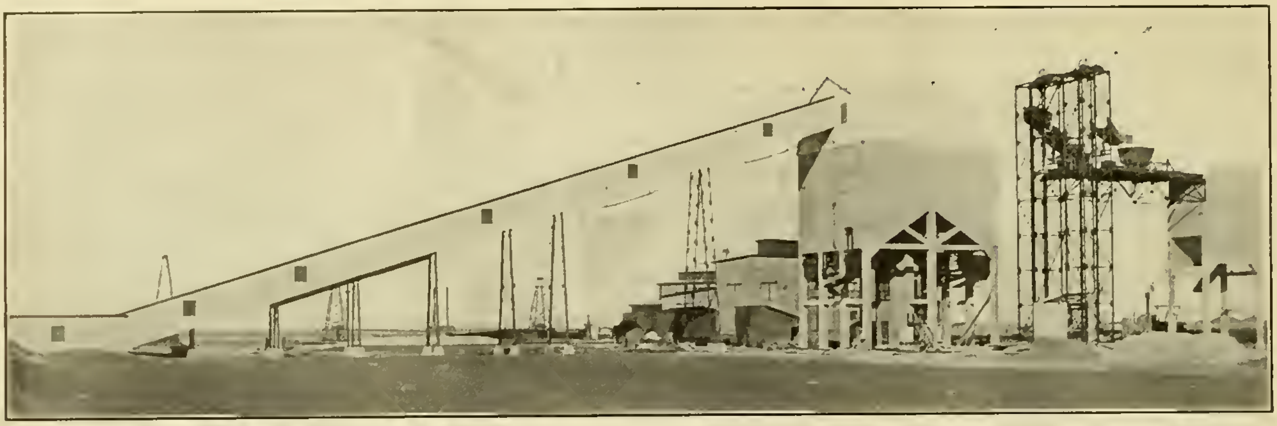
[redacted] Superintendent.

[redacted] Div Master Mechanic.

____________ Fuel Supervisor.

Date ____________

FORM 1133, WHICH IS PRINTED ON OILED PAPER. THE ITEMS ARE TRANSFERRED FROM 1133A AND FROM THIS ARE MADE BLUE PRINTS THAT ARE SENT TO ALL INTERESTED AND ALSO POSTED ON BULLETIN BOARDS AT THE LOCOMOTIVE TERMINALS.



COALING STATION AND CINDER HANDLING PLANT ERECTED BY THE ROBERTS & SCHAEFER CO. AT CLOVIS, N. M. THIS IS OF REINFORCED CONCRETE AND STEEL CONSTRUCTION THROUGHOUT. THE COALING STATION USES A CONVEYOR BELT AND THE CINDER HANDLING PLANT A BALANCED BUCKET AND TRAM-CAR HANDLING ARRANGEMENT. THIS COALING STATION HAS A 750 TON CAPACITY STORAGE POCKET AND IS EQUIPPED WITH FOUR 6-TON WEIGHING HOPPERS.

Practically all of the coal chutes of the weighing hopper type that have been installed in the past few years have been built by either the Roberts & Schaefer Co. or Fairbanks, Morse & Co. They are all of the mechanically operated design of different capacities and arrangements to suit the different conditions. The illustrations show the general appearance of a number of these coaling stations and a few typical examples will be briefly described.

At Clovis, N. M., a 750-ton capacity concrete and steel station, built by the Roberts & Schaefer Co., has been provided. This plant is of the belt conveyor type, the coal being placed in a receiving hopper 250 ft. away from the coal pocket. From this hopper it is delivered to the belt conveyor by a reciprocating feeder. The coal pocket itself is of reinforced concrete, with the exception of the monitor house, which is of steel covered with asbestos protected metal. The trestle for the belt conveyor is entirely of steel, with the exception of the housing for the belt, which is of wood covered with corrugated asbestos protected metal. The conveying apparatus is in duplicate and the station is arranged to coal four tracks. From the storage hopper the coal is delivered to four 6-ton weighing hoppers, two on each side, each having chutes arranged to serve two tracks. These weighing hoppers are connected to the scale beam, which is balanced before and after the locomotive takes its supply.

The plant is motor driven, the motor being placed at the head of the main conveyor in the monitor house. An auxiliary motor is provided on the trestle for bringing the coal up from the receiving hopper to the boiler house coal storage bin, located underneath it.

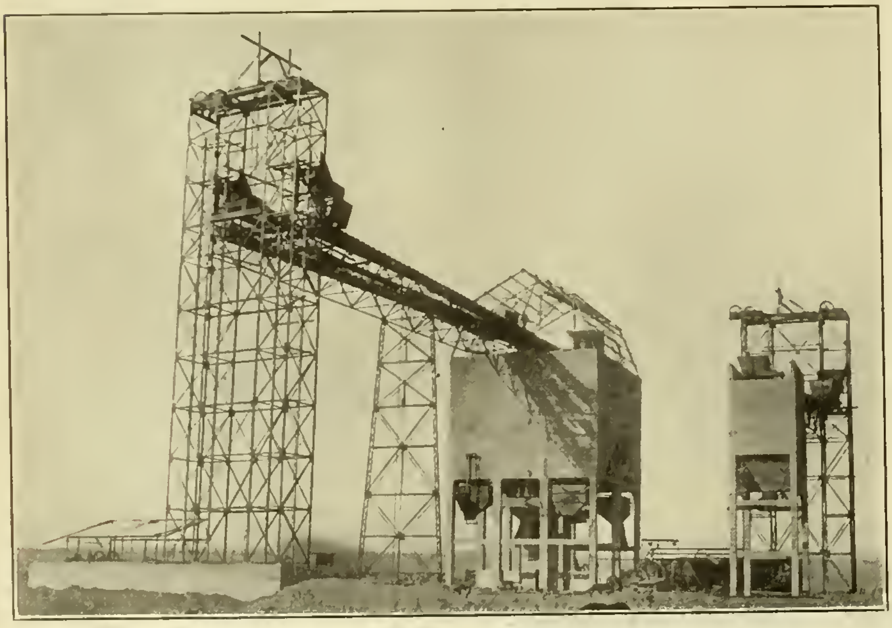
The same station encloses the sand equipment, the green sand being delivered by the belt conveyor to a storage bin near the top of the coal chute, from which it falls by gravity to a drier located at the ground level and after drying is elevated by air to another bin from which it is delivered to the locomotives by gravity.

In connection with this coaling station there is a cinder handling plant, consisting of a storage bin with a capacity of 146 cu. yds., built entirely of reinforced concrete, the cinders being delivered to it by an elevating system consisting of a pair of Holman balanced buckets and an automatic tram car system. The cinders are drawn from the locomotive into the cinder pits, there being two, one on each side of the receiving hopper, from which they are dumped into the buckets and then hoisted and delivered into the tram car system, which conveys them to the storage pocket. The operation of the whole apparatus is automatic.

The photograph of this plant clearly shows both the coaling station and the cinder handling arrangement. The boiler house storage bin under the conveyor trestle had not been installed when the photograph was taken.

Another station built by the same company at Belen, N. M., is very similar to that of Clovis, with the exception of the method of conveying the coal from the receiving hopper to the storage.

In this case Holman balanced bucket elevators working in connection with an automatic tram car system, very similar to the cinder plant at Clovis, are used. The two elevating buckets are connected directly to a hoist placed between them and the cable is so wrapped around the drum that when one bucket is loading at the bottom the other is unloading at the top. The tram cars are also connected to the same hoist and are entirely automatic in their operation, one car being dumped into the pocket while the other is receiving its load at the hoist. This plant is entirely of



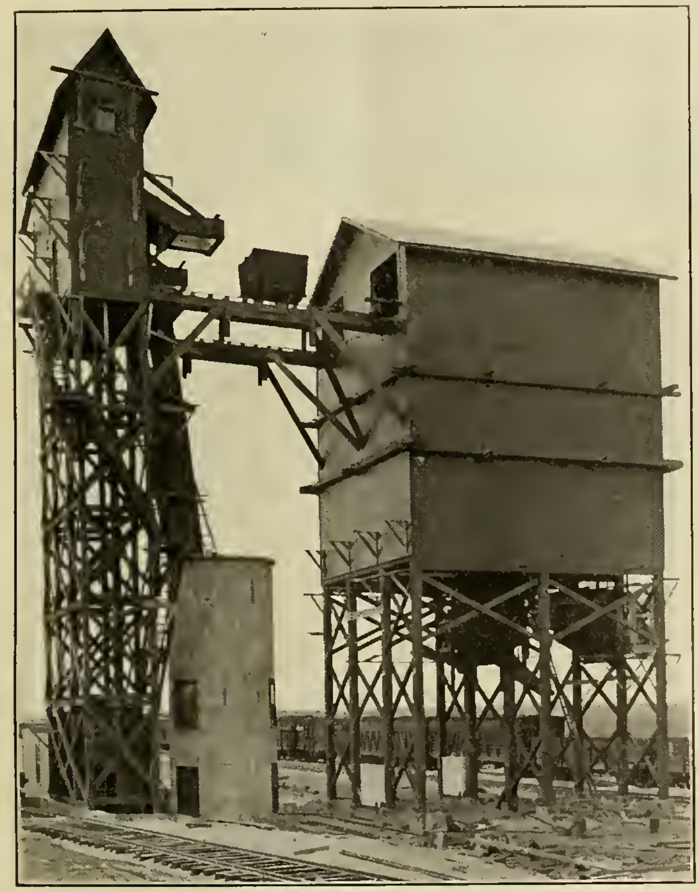
A CONCRETE AND STEEL COALING STATION ERECTED BY ROBERTS & SCHAEFER CO. AT BELEN, N. M. IN THIS STATION THE COAL IS ELEVATED BY HOLMAN BALANCED BUCKETS AND TRANSFERRED BY A DOUBLE AUTOMATIC TRAM-CAR SYSTEM. BELOW THE STORAGE BIN ARE FOUR 6-TON AUXILIARY WEIGHING POCKETS, ARRANGED THE SAME AS AT CLOVIS. AT THE RIGHT IS SEEN A CINDER HANDLING PLANT OF THE SAME CONSTRUCTION AND ARRANGEMENT AS THE COALING STATION.

steel and reinforced concrete and therefore absolutely fireproof.

At Belen there is also a cinder handling plant of the same design and arrangement as at Clovis.

The same company also erected a 350-ton plant at Vaughn, N. M., constructed entirely of wood except the sand storage bin, which is of reinforced concrete. This plant is arranged similar to the one at Belen, using the Holman balanced bucket elevators in connection with an automatic tram car system. It is arranged to coal three tracks and has the 6-ton auxiliary scale hoppers the same as the other plants.

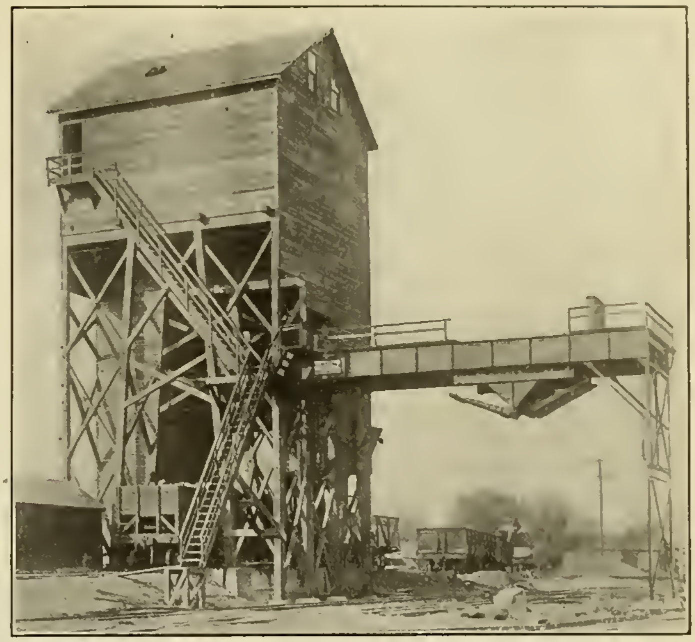
The four stations at Becker, Taivan, Willard and Yesso, N. M., that are practically identical in design were also constructed by the same company. The one at Becker has a 350-ton storage capacity, and the others 250-ton. The plants are of the simple Holman balanced bucket type, where the coal is received into a hopper at one side of the station and delivered by a pair of balanced buckets directly into the coal pocket above. They are entirely of wooden construction with concrete foundations and concrete receiving hoppers. The locomotives are coaled on two tracks, one beneath the pocket and one at the side. They have the same auxiliary weighing hoppers as the other plants mentioned above. The power for these four plants consist of a gasoline engine driving a reversible hoist.



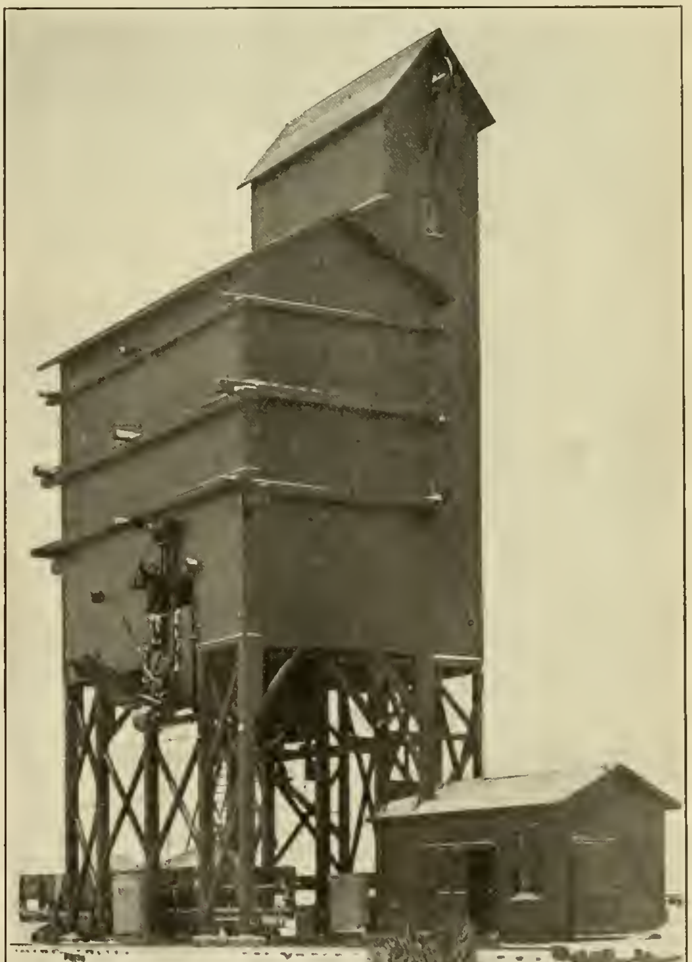
COALING STATION ERECTED BY ROBERTS & SCHAEFER CO., AT VAUGHN, N. M. IT IS OF TIMBER CONSTRUCTION AND USES HOLMAN BALANCED BUCKETS WITH AUTOMATIC TRAM CARS FOR FILLING THE STORAGE POCKETS. THE CONCRETE BUILDING IN THE CENTRE IS FOR SAND STORAGE.

Fairbanks, Morse & Co. have erected eleven coaling stations for the Santa Fe, which are arranged on two general systems, one having a coaling bridge spanning several tracks and the other arranged to coal on the two tracks alongside the building only.

One of the illustrations shows the station at Augusta, Kans., which is of the type having the bridge. This plant is arranged to coal four tracks, one on either side of the building and two beneath the bridge. The coal going to the locomotive tender is all handled through 10-ton suspension scale pockets, there being



300 TON COALING STATION ERECTED BY FAIRBANKS, MORSE & CO., AT AUGUSTA, KAN. THIS STATION IS TYPICAL OF THE LARGE NUMBER ERECTED BY THIS COMPANY FOR THE SANTA FE AND IS PROVIDED WITH 10-TON AUXILIARY SCALE POCKETS, WHICH PERMIT THE ACCURATE WEIGHING OF THE COAL PUT ON EACH LOCOMOTIVE TENDER. THIS STATION COALS FOUR TRACKS AND OTHERS OF THE SAME TYPE WITHOUT THE BRIDGE COAL TWO TRACKS

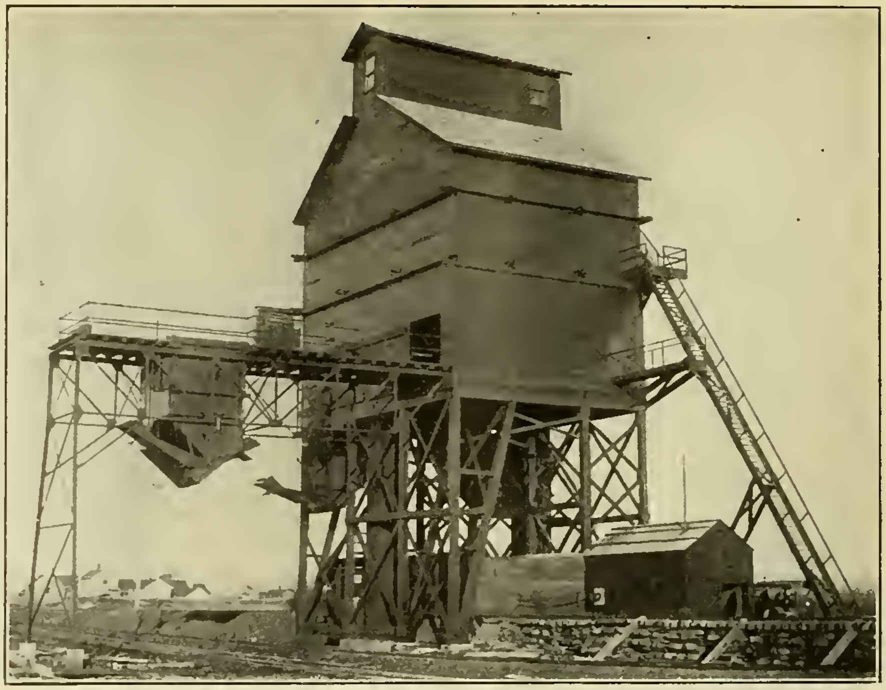


COALING STATION ERECTED AT BECKER, N. M., BY THE ROBERTS & SCHAEFER CO. THIS PLANT IS TYPICAL OF FOUR PLANTS CONSTRUCTED ON THE EASTERN RAILWAY OF MEXICO AND USES THE HOLMAN BALANCED BUCKETS FOR ELEVATING. THEY SERVE TWO TRACKS AND ARE PROVIDED WITH TWO 6-TON AUXILIARY WEIGHING HOPPERS.

one of these pockets on the bridge furnished with two outlet chutes.

All of the stations erected by this company are of the same general arrangement, and have a 300 net ton total capacity. The coal is discharged into the receiving hopper below the center of the station, and from there is conveyed by a continuous loader into the elevator boot and from this point elevated by means of a bucket conveyor to the storage bin above. The 10-ton scale pockets are filled from the storage bin by means of undercut gates operated from below. The power is furnished by a Fairbanks, Morse & Co. 15 h.p. horizontal gasolene engine and a car puller equipment, having a capacity to handle two loaded cars over the receiving hopper, is provided at each station. The handling capacity of all of these plants is 70 tons per hour.

At the stations provided with the coaling bridges the suspended 10-ton scale pocket on the bridge is filled by a two-ton side dump car, which receives its supply directly from the storage bin. The scales in this type of station are located on the bridge, but where no bridge is provided the scale beam is located on the ground. The beams read in 20 lb. increments and the amount of coal withdrawn from the pocket is automatically recorded on single or manifold tickets.



COALING STATION ERECTED BY THE ROBERTS & SCHAEFER CO. AT BARING, MO. THIS PLANT IS OF THE CHAIN AND BUCKET TYPE AND HAS A CAPACITY OF 500 TONS. THERE ARE TWO SUSPENDED WEIGHING POCKETS ON THE STATION PROPER, AND IN ADDITION THERE IS A STEEL BRIDGE WITH A 10-TON WEIGHING HOPPER FOR SERVING THE TWO MAIN LINE TRACKS. THIS HOPPER IS SERVED BY MEANS OF A 3-TON CAR, WHICH RECEIVES ITS LOAD FROM THE MAIN STORAGE POCKET. THE PLANT IS OF WOODEN CONSTRUCTION WITH THE EXCEPTION OF THE BRIDGE.

INTERNATIONAL RAILWAY FUEL ASSOCIATION

SECOND ANNUAL CONVENTION, LA SALLE HOTEL (18TH FLOOR), CHICAGO, MAY 23-26.

The hours of session will be from 9 A. M. to 1 P. M. on the four days, and the members will be welcomed on the opening day by the Mayor of Chicago and addresses are contemplated by other prominent men

Members are particularly urged to bring their families to this convention. The hours of session were purposely arranged without intermission to permit of an opportunity for recreation and to establish a better acquaintance between the members. The matter of entertainment (entire expense of which will be borne by the Association) will be a distinct feature this year. Something will be doing every day in connection with complimentary theater parties to members and their friends, a trip across Lake Michigan and return on a commodious passenger steamer, or a visit to one of Chicago's large amusement parks; besides automobile rides, etc., are being arranged for.

The International Railway Fuel Association is the largest railway organization for its age ever in existence, and perhaps has attracted more attention in this country and Europe than any other association. The commodity "Fuel" is of more importance to railroads from a cost standpoint than anything else purchased, and with this live subject is it any wonder that all of our large and small railroads are interested as members in this association.

The list of subjects to be read and discussed is as follows:

PAPERS NOS. 1 AND 5 CONSOLIDATED.

"Grade of fuel most suitable for locomotive use, considering cost per unit of traffic and best interests of producer." "Recommended methods of preparing coal as to size for locomotives."

J. G. Crawford, Chairman, Fuel Engineer, C., B. & Q. R. R., Chicago.
LeGrand Parish, S. M. P., L. S. & M. S. Ry., Cleveland, Ohio.
Curtis Scovill, A. G. S. A., Central Coal & Coke Company, Dallas, Texas.

PAPER NO. 2.

"Standard uniform blank for reporting all items of cost in connection with fueling stations and handling fuel, for all types of stations and conditions"

R. Emerson, Chairman, Consulting Engineer, A., T. & S. F. Ry., Chicago, Ill.
F. V. Hetzel, Chief Engineer, Link Belt Co., Nicetown, Pa.
E. A. Averill, Editor, *American Engineer and Railroad Journal*, New York, N. Y.
N. M. Rice, G. S. K., A., T. & S. F. Ry., Topeka, Kansas.

PAPER NO. 3.

"Accounting for fuel consumed; individual records of performances."

W. E. Symons, Chairman, C. & G. W. Ry., Chicago.
E. A. Foos, C. C. Fuel, Rail and Tie Dept., C., B. & Q. R. R., Chicago.
E. J. Roth, Jr., Fuel Inspector, B. & O. R. R., Baltimore, Md.

PAPER NO. 4.

"Methods of purchasing fuel with regard both to traffic conditions and to producers' interests. Relation between producer and railroad."

W. H. Huff, Chairman, V. P., Victor-American Fuel Co., Denver, Colo.
L. L. Chipman, G. S. M., Fidelity Coal Mining Co., Kansas City, Mo.
W. K. Kilgore, Fuel Agent, C., M. & St. P. Ry., Chicago.

PAPER NO. 6.

"Methods of supervision, instruction and encouragement in locomotive operation to secure greatest efficiency in fuel consumption."

D. Meadows, Chairman, Asst. Div. M. M., Michigan Central R. R., St. Thomas, Ont.
W. C. Hayes, Supt. Locomotive Operation, Erie R. R., New York, N. Y.
J. McManamy, R. F. of E., Pere Marquette R. R., Grand Rapids, Mich.

SPECIAL PAPER.

"Character of membership that should be encouraged in the Association and steps to secure that membership."

S. L. Yerkes, Fuel Agent, Queen & Crescent System, Lexington, Ky.

SPECIAL PAPER.

"Methods of kindling locomotive fires."

C. F. Richardson, Asst. to G. S. M. P., C., R. I. & P. Ry., Chicago.

SPECIAL PAPER (With Lantern Slides).

"Mechanical Preparation of Fuel."

Professor H. H. Stoek, Professor of Mining Engineering, University of Illinois.

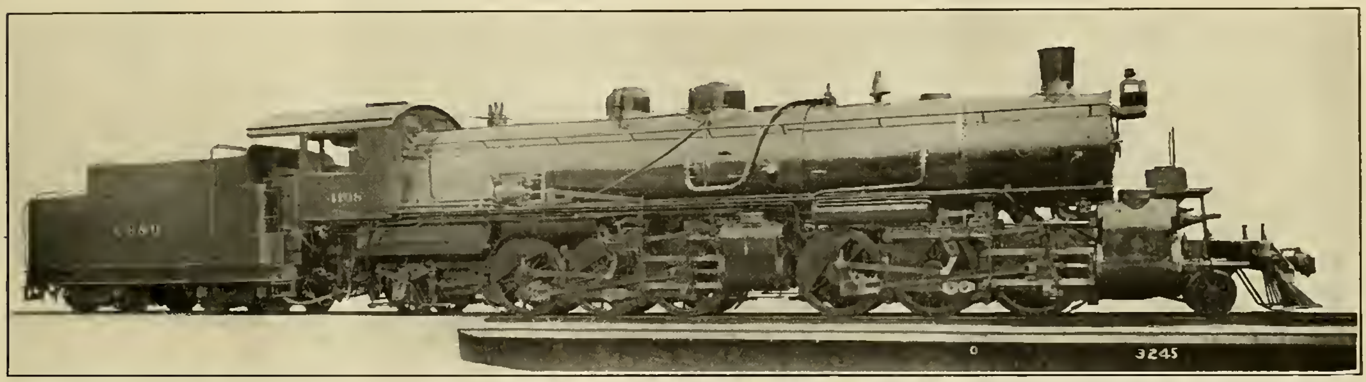
By placing the maintenance of belting in the hands of a specialist, with instructions to prevent failures, not remedy them, and to use only the best quality of material for repairs and renewals, the belting expense in a large railroad shop decreased from $1,000 to $300 per month and the number of failures from 300 to 55 in about 15 months. The conditions before this was done were not worse than in many other railroad shops.

MALLET ARTICULATED COMPOUND LOCOMOTIVE.

2-6-6-2 TYPE.

A GENERAL DESCRIPTION OF LOCOMOTIVE DESIGN WHICH INCORPORATES A VERY LARGE FEED WATER HEATER, A FIRE TUBE SUPERHEATER AND A REHEATER. TEN OF THESE ENGINES HAVE RECENTLY BEEN DELIVERED TO THE CHICAGO, BURLINGTON & QUINCY RAILROAD BY THE BALDWIN LOCOMOTIVE WORKS.

The Chicago, Burlington & Quincy Railroad has had in service for some time eight Mallet compound locomotives of the 2-6-6-2 type of a design very similar to those on the Great Northern Railway, which were illustrated on page 371 of the 1906 volume of this journal. These engines are not provided with superheaters or feed water heaters. The company has recently received ten more locomotives of the same wheel arrangment, which, however, include an Emerson fire tube superheater*, a feed water heater having a heating surface of 2,172 sq. ft. and a reheater consisting of 19 2-in. tubes 128½ in. long located in a large 17 in. flue through the center of the feed water heater. These locomotives are arranged to burn lignite and will be used in freight service on maximum grades of 1.6 per cent. They are designed to traverse 20 deg. curves.



MALLET ARTICULATED COMPOUND LOCOMOTIVE FOR THE CHICAGO, BURLINGTON AND QUINCY RAILROAD. TEN OF THESE HAVE RECENTLY BEEN DELIVERED BY THE BALDWIN LOCOMOTIVE WORKS. THEY ARE ARRANGED TO BURN LIGNITE AND ARE EQUIPPED WITH A HIGH DEGREE SUPERHEATER AND REHEATER AND A VERY LARGE CAPACITY FEED WATER HEATER. THE TOTAL WEIGHT IS 361,350 LBS., OF WHICH 304,500 LBS. IS ON DRIVERS. THEY HAVE 64 IN. WHEELS.

A straight top boiler with a radial stay fire box, having a grate area of 63.8 sq ft., forms the steam generating section of the boiler. The boiler shell contains 218 2¼ in. steel tubes, 16 ft. 6 in. long and 28 5 in. tubes of the same length, which enclose the superheater elements. This gives a total tube heating surface of 2,708 sq. ft., the fire box having 210 sq. ft. of heating surface, making the evaporating surface equal to 2,918 sq. ft. The boiler shell is 78 in. in diameter and the dome is mounted a little ahead of the center of the length of the tubes.

Steam from the throttle valve is carried through the usual dry pipe to the front flue sheet, where it passes through the T head into the two superheater headers. This type of superheater has vertical headers, which are simply enlarged steam pipes with the proper walls and passages to divide the saturated and superheated steam sections. Each superheater has fourteen elements placed in two vertical rows of seven each. The headers have a cross connection at the bottom to act as an equalizer between the superheated steam compartments.

The high pressure cylinders are cast separately from the saddle and the steam from the superheater passes into a short passage in the saddle, from which it is carried by a short elbow pipe to a passage in the center of the cylinders, thence to the 13 in valve chamber. The exhaust emerges from the high pressure cylinders through a 6 in. passage on the back face from which it is carried to a passage in the saddle by a short section of piping and thence upward from the center of the saddle through an elbow pipe to the reheater. The reheater consists of two cast steel headers circular in shape, between which are 19 2 in. tubes 128½ in. in length. These headers have ground ball joints with the elbow pipes at either end. The discharge from the reheater is carried down to the bottom of the smoke box and thence through a flexible receiver pipe to a steel casting which forms part of the front frames and to which the low pressure cylinders are bolted. The construction and arrangement of the passages at this point are the same as were used on the Southern Pacific design, illustrated on page 181 of the May and 367 of the September, 1909, issues of this journal. The low pressure piston valves are 15 in. in diameter.

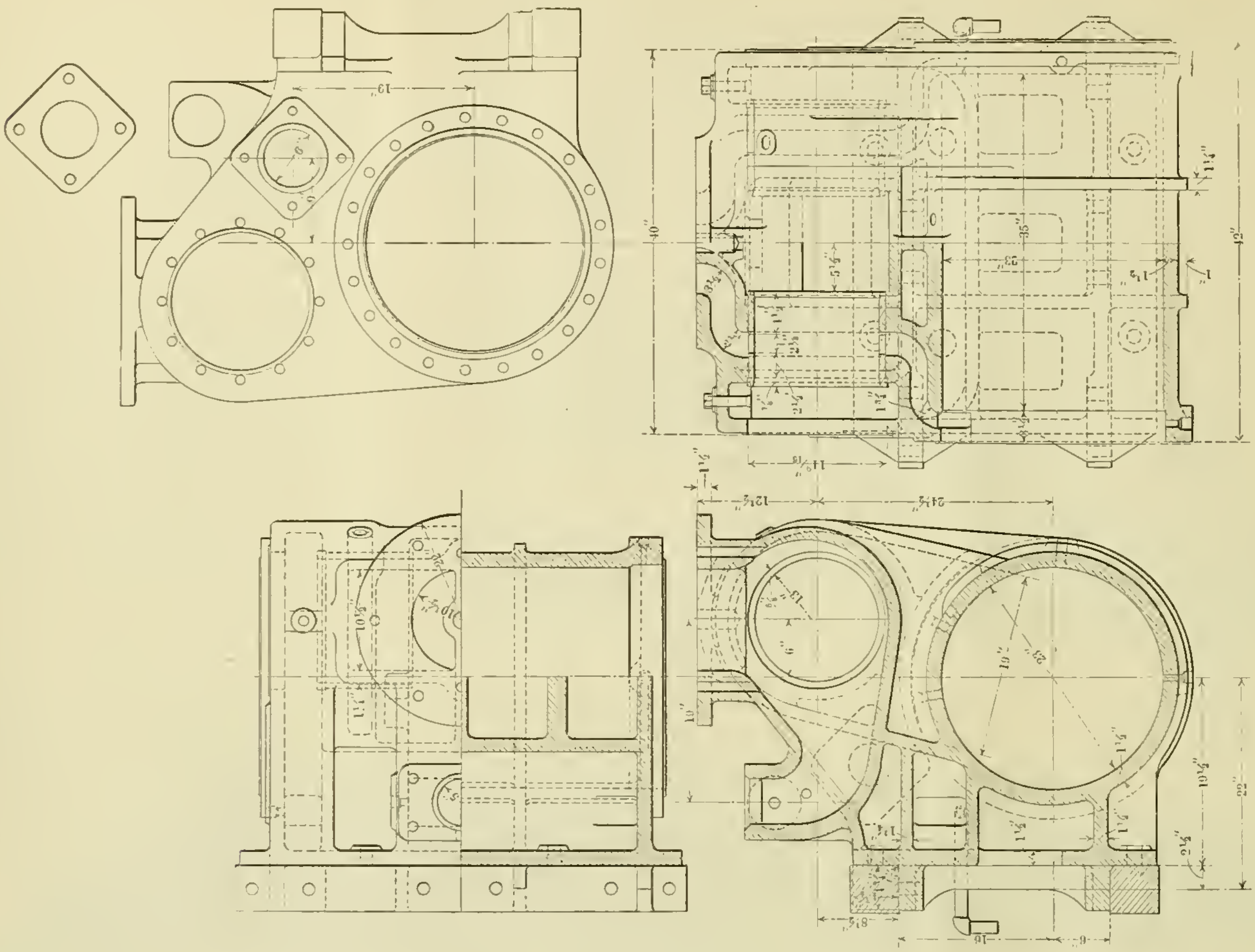
The feed water heater is of unusual capacity and in addition to the large central 17 in. flue has 406 2¼ in. flues distributed over its whole cross section. It is fed by two non-lifting injectors, the admission being on the center line at either side and discharge through a check valve at the top into the check valves on the side of the boiler proper. The front section of the boiler is separable from the rear section, the joint being just back of the feed water heater and all piping or other parts continuing by this joint are arranged to be easily disconnected.

One of the illustrations shows the arrangement of the front end, which the company's experience has indicated to be very satisfactory. The stack has a long interior extension and very large bell shaped section at the bottom, which does not require a petticoat pipe.

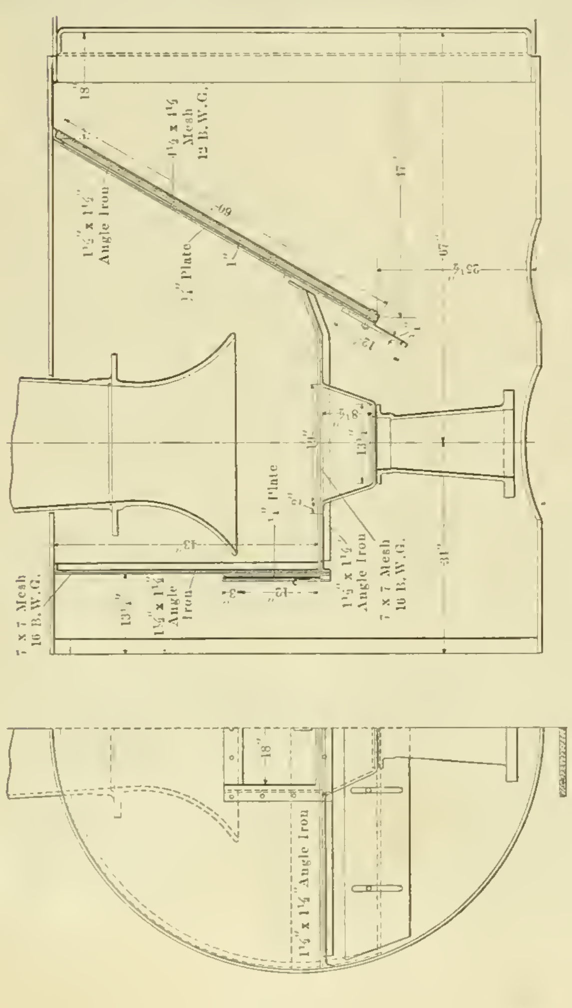
The design and construction of the grates is shown in another illustration. As will be seen, they are designed with very narrow openings in large square rocking frames and are arranged to shake in two sections on either side of the center frame. A small dead grate is provided at either end of the fire box. A single fire door is used.

The frames are of cast steel 5 inches wide, with a single hinge connection. The frames of the rear engine have separate back sections, also of cast steel. The pedestal binders are of the same

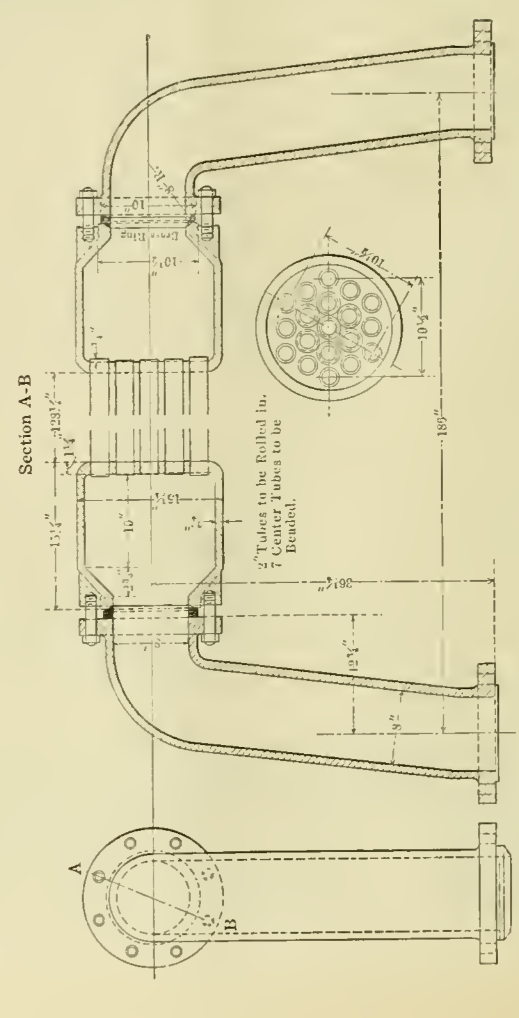
* See AMERICAN ENGINEER, February, 1910, page 64.



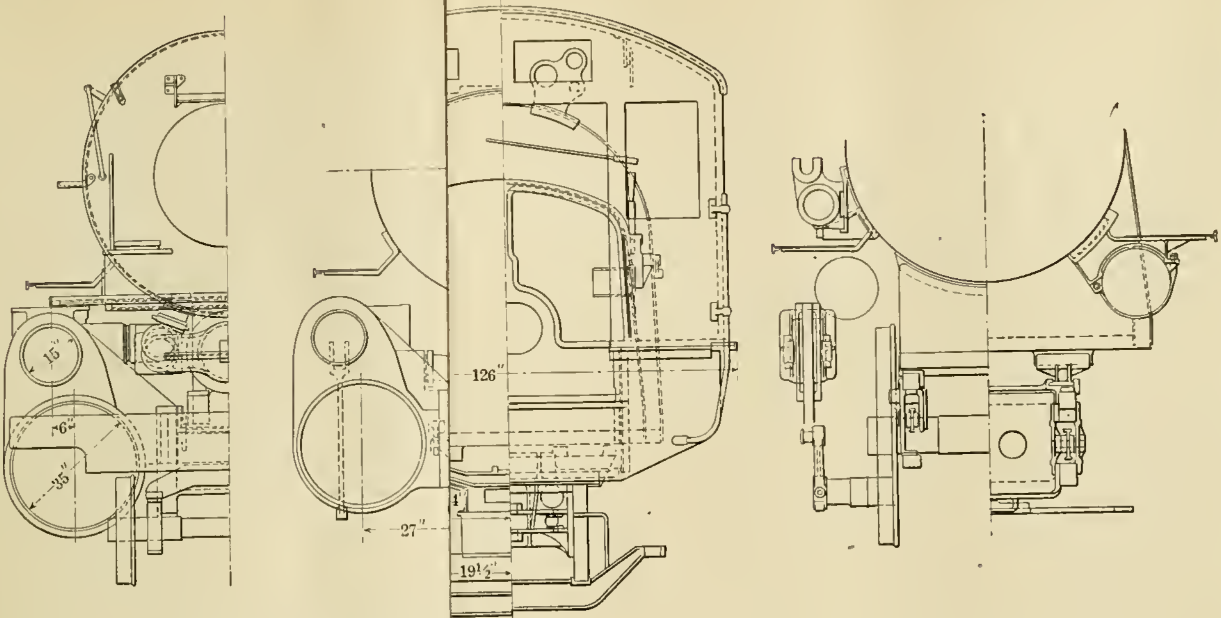
DETAILS SHOWING THE GENERAL CONSTRUCTION OF THE HIGH PRESSURE CYLINDERS; CHICAGO, BURLINGTON & QUINCY MALLET COMPOUND.

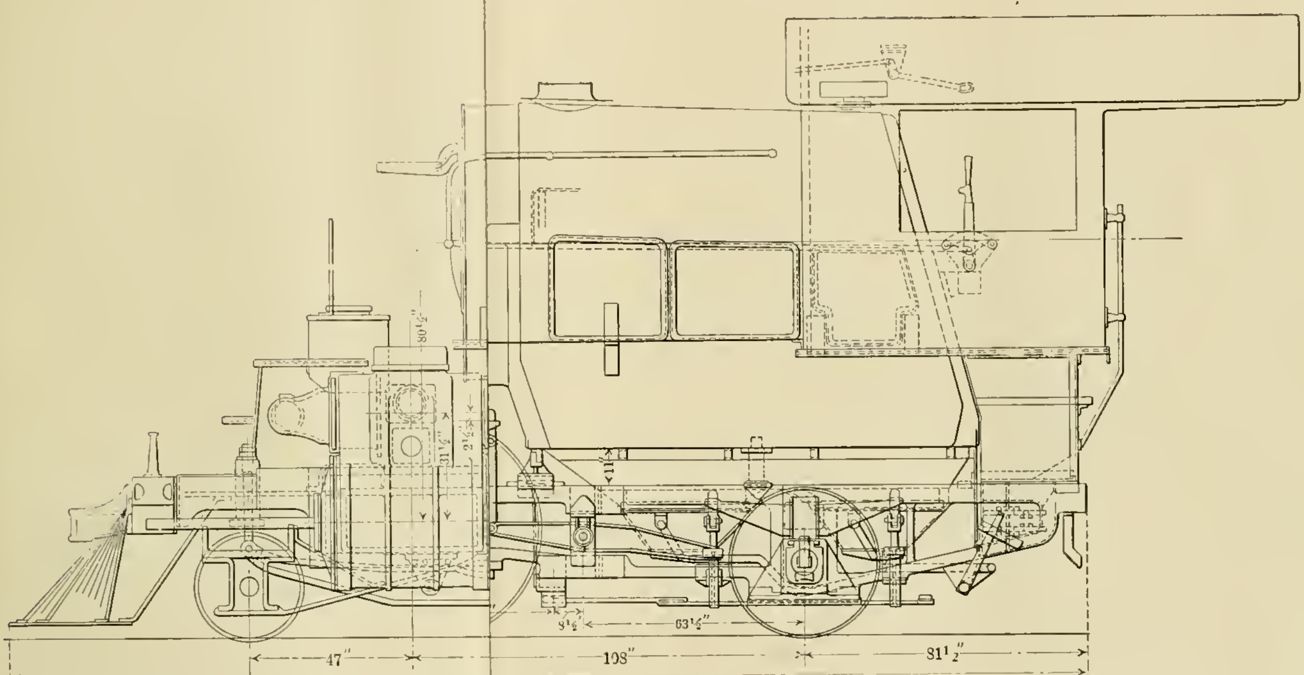


GENERAL ARRANGEMENT OF THE FRONT END OF THE CHICAGO, BURLINGTON & QUINCY MALLET COMPOUND DESIGNED FOR BURNING LIGNITE.

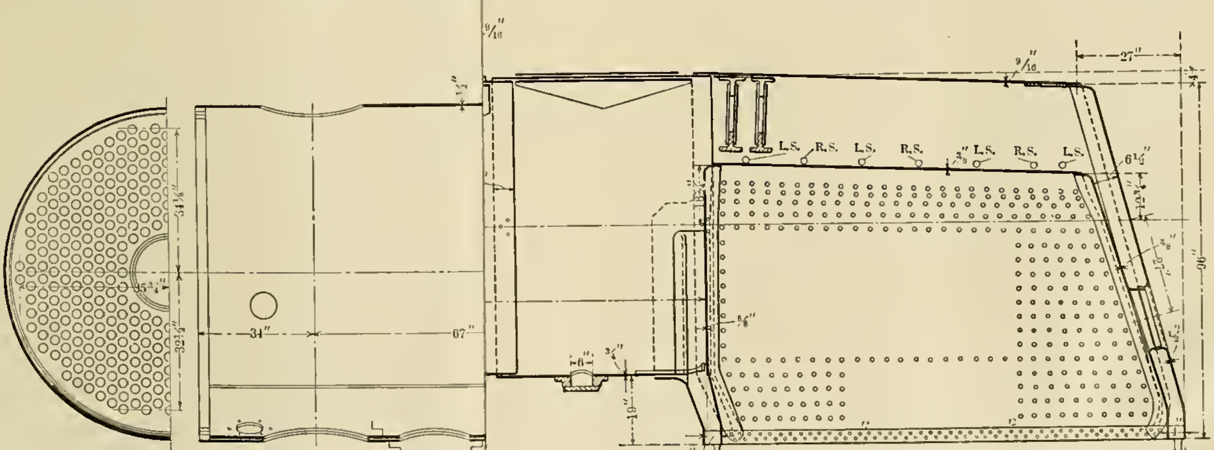


DETAILS OF THE REHEATER HEADERS AND CONNECTIONS AS APPLIED TO THE CHICAGO, BURLINGTON & QUINCY MALLET COMPOUND LOCOMOTIVE. THE TUBES PASS THROUGH A LARGE FLUE IN THE CENTER OF THE FEED WATER HEATER.

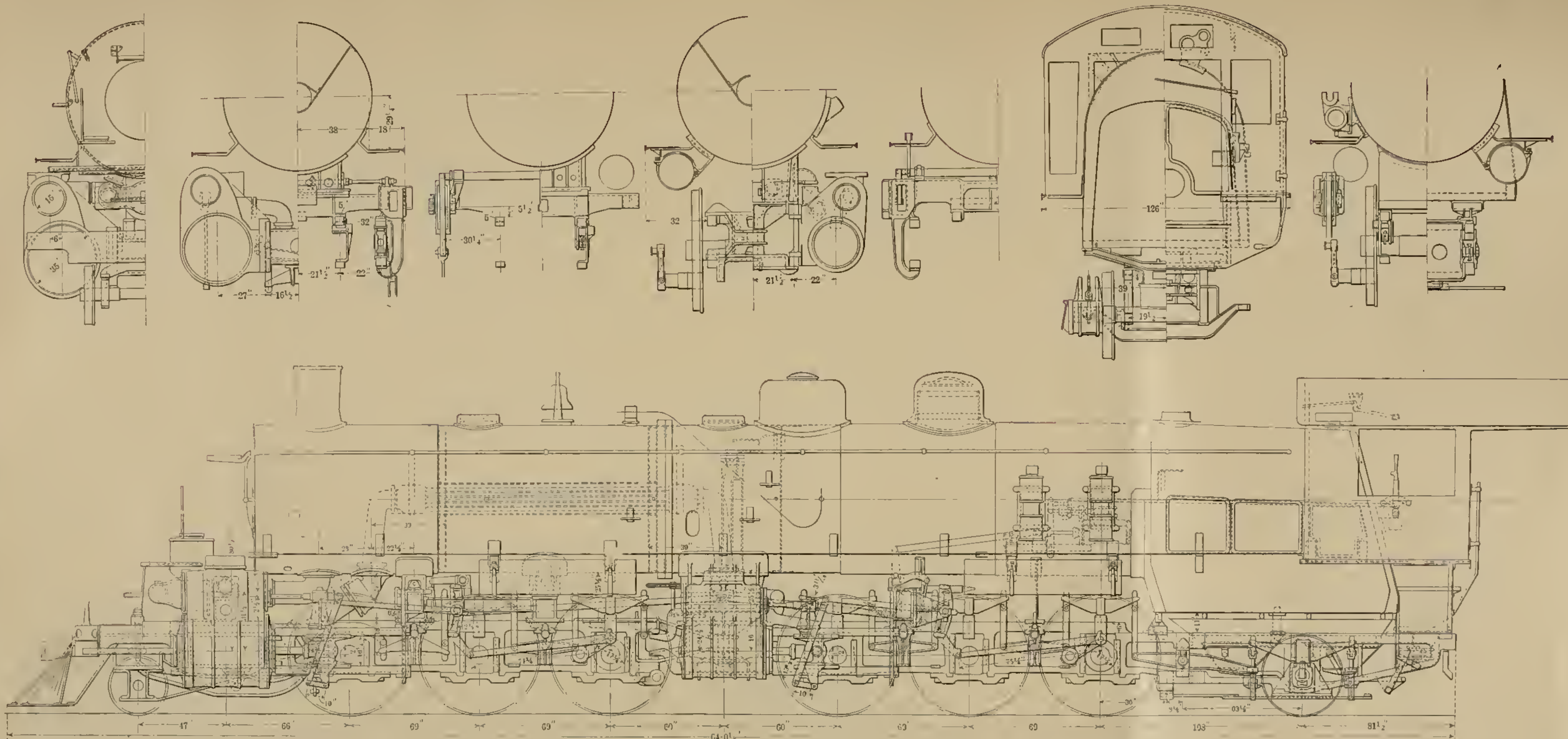




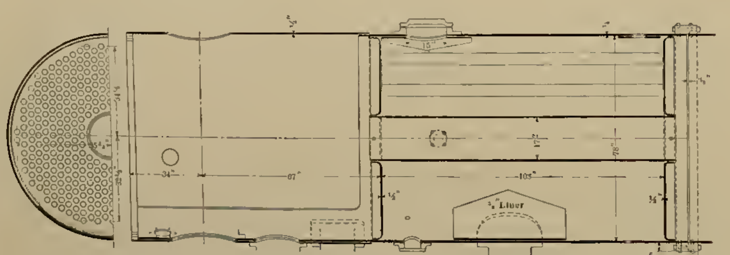
GENERAL ELEVATION AND SECTIONS OF MALLE D FOR SERVICE ON A 1.6 PER CENT. GRADE AND TO TRAVERSE 20 DEG. CURVES.



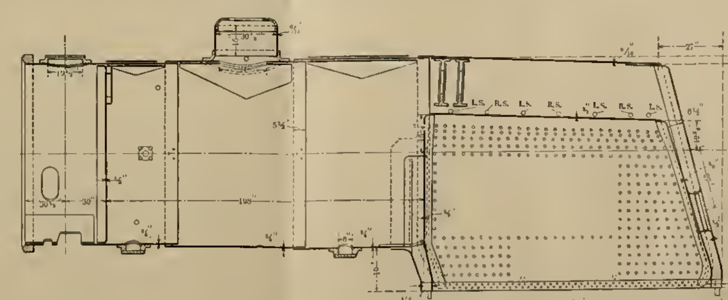
FORWARD SECTION OF THE BOILER SI R THE CHICAGO, BURLINGTON & QUINCY RAILROAD MALLET ARTICULATED
17-IN. CENTRAL ; THE SECTION OF THE BOILER BACK OF THE CONNECTING RING.



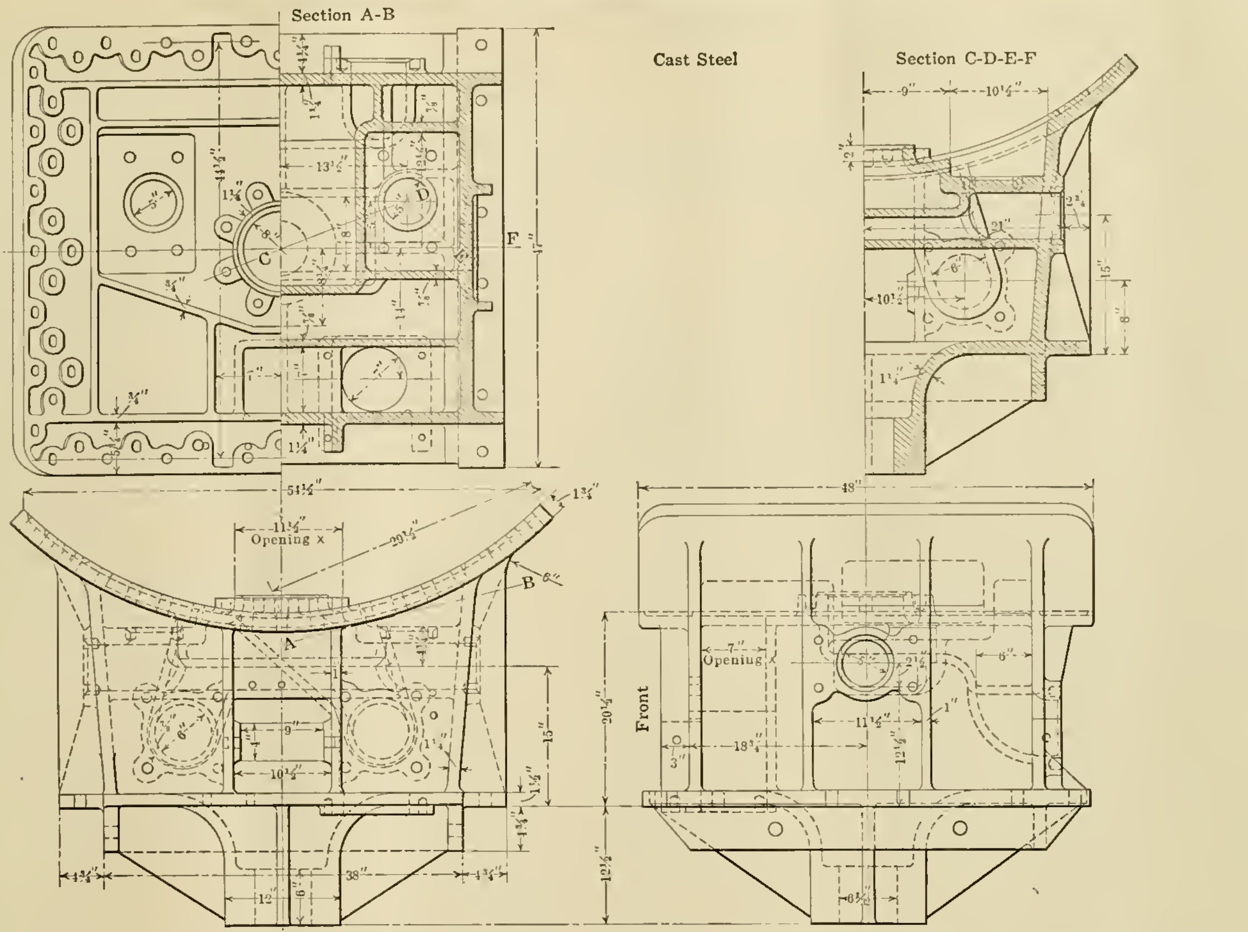
GENERAL ELEVATION AND SECTIONS OF MALLET COMPOUND LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD. THESE LOCOMOTIVES ARE DESIGNED FOR SERVICE ON A 1.6 PER CENT. GRADE AND TO TRAVERSE 20 DEG. CURVES.



FORWARD SECTION OF THE BOILER SHOWING THE FEED WATER HEATER AND FRONT END. THE LARGE 17-IN. CENTRAL FLUE IS PROVIDED FOR THE REHEATER PIPES.



SECTIONAL ELEVATION OF 78-IN. BOILER FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD MALLET ARTICULATED COMPOUND LOCOMOTIVE. THIS VIEW SHOWS THE SECTION OF THE BOILER BACK OF THE CONNECTING RING.



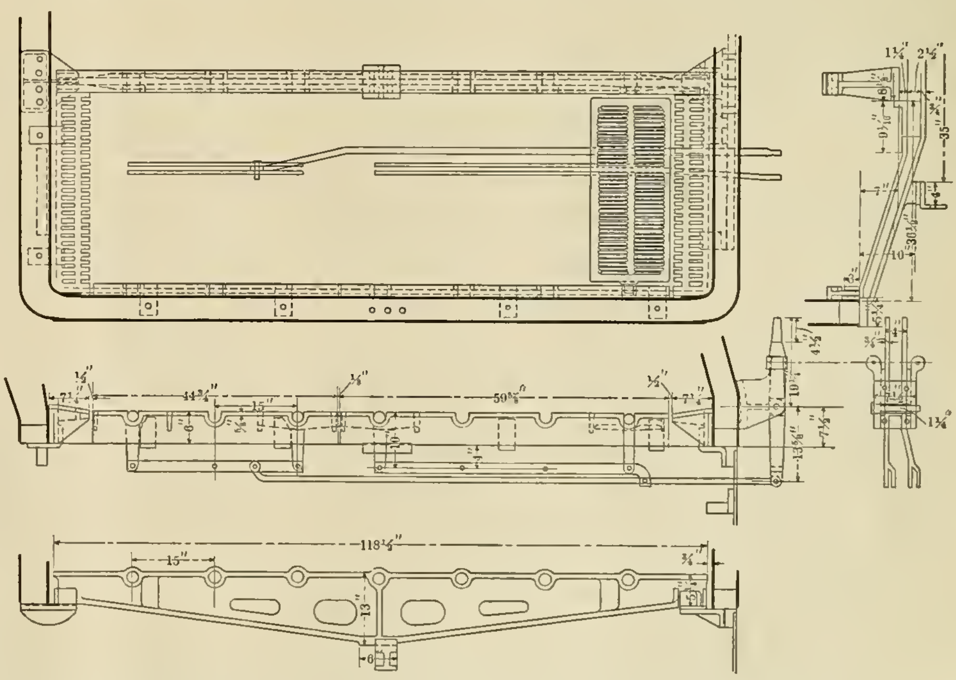
THE HIGH PRESSURE CYLINDER SADDLE SHOWING THE PASSAGES FOR SUPERHEATED STEAM EMERGING ON EITHER SIDE AND THE EXHAUST PASSAGES FROM THE REAR, COMBINING INTO THE 8-IN. OPENING IN THE CENTER, TO WHICH THE CONNECTION TO THE REHEATER IS MADE.

material, and they are lugged and bolted to the pedestals. The front truck is equalized with the leading driving wheels through an inverted leaf spring, suspended from yokes placed over the forward driving boxes. The back end of the equalizer rests on the middle of this spring. The rear truck is of the "Hodges" pattern,* with outside journals. The side swing is taken by the spring hangers, which are jointed for the purpose.

The boiler is supported, on the front frames, by two waist bearers, both of which are normally under load. The front bearer carries the controlling spring, and acts as a support for the low pressure guide bearers. The high pressure guide bearers are bolted to a specially designed steel casting, which also serves as a support for the link bearings. Two waist sheets support the boiler barrel over the rear frames, and the mud ring is carried by sliding shoes in front and a buckle plate at the rear.

Reversing is effected by the Baldwin power gear, and the two reverse shafts are connected by a single reach rod placed on the center line and fitted with a universal joint. Both valve motions are simple in design, and have eccentric rods of ample length. The links of the front engine are trunnioned on cast steel supports, which are placed outside the second pair of drivers, and span the distance between the two waist bearers.

In order to avoid flexible oil pipe connections, the low pressure cylinders are lubricated by two Hart sight feed oil pumps driven from the forward valve motion. The high pressure cylinders are lubricated from the cab in the usual manner.



GENERAL DETAILS OF THE GRATES AND FRAMES OF THE CHICAGO, BURLINGTON & QUINCY MALLET THIS LOCOMOTIVE BURNS LIGNITE COAL AND HAS A GRATE AREA OF 63.8 SQ. FT.

* See American Engineer, June, 1909, page 228.

The tender is designed in accordance with the Railroad Company's practice. The frame is composed of 12 in. steel channels, and the tank is of the water bottom type. The trucks are of equalized pedestal design, with forged and rolled steel wheels having rims three inches thick.

These locomotives are of exceptional capacity, and the heating surface of the feed water heater is greater than that provided in any engines previously constructed. The principal dimensions are presented in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Lignite
Tractive effort	70,500 lbs.
Weight in working order	361,650 lbs.
Weight on drivers	304,500 lbs.
Weight on leading truck	21,000 lbs.
Weight on trailing truck	36,150 lbs.
Weight of engine and tender in working order	515,000 lbs.
Wheel base, rigid	11 ft. 6 in.
Wheel base, total	51 ft. 5 in.
Wheel base, engine and tender	83 ft. 2½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.23
Total weight ÷ tractive effort	5.13
Tractive effort x diam. drivers ÷ boiler heating surface	1,550.00
T. E. x D. D. ÷ boiler and feed heating surface	890.00
Total boiler heating surface ÷ grate area	45.70
Fire box heating surface ÷ total boiler heating surface, per cent	7.10
Weight on drivers ÷ total boiler heating surface	104.00
Total weight ÷ total boiler heating surface	123.50
Volume equivalent simple cylinders, cu. ft	24.10
Total boiler heating surface ÷ vol. equiv. cylinders	120.50
Grate area ÷ vol. equiv. cylinders	2.65
CYLINDERS.	
H. P. Diameter	23 in.
L. P. Diameter	35 in.
Stroke	32 in.
VALVES.	
Kind	Piston
Diameter H. P	13 in.
Diameter L. P	15 in.
WHEELS.	
Driving, diameter over tires	64 in.
Driving, thickness of tires	4 in.
Driving journals, diameter and length	10 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6 x12 in.
Trailing truck wheels, diameter	42½ in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	78 in.
Firebox, length and width	120 x 78¼ in.
Firebox plates, thickness	⅜ and ⅝ in.
Firebox, water space	F-4½, S and B 4 in.
Fire tubes, number and outside diameter	28-5 in., 218-2¼ in.
Fire tubes, length	16 ft. 6 in.
Heater tubes, number and diameter	406-2¼ in.
Heater tubes, length	8 ft. 11 in.
Heating surface, fire tubes	2,708 sq. ft.
Heating surface, firebox	210 sq. ft.
Evaporating heating surface, total	2,918 sq. ft.
Superheater heating surface	464 sq. ft.
Feed water heating surface	2,172 sq. ft.
Grate area	63.3 sq. ft.
Centre of boiler above rail	114½ in.
TENDER.	
Tank	Water bottom
Frame	12 in. chan.
Wheels, diameter	37 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons.

LONGITUDINAL JOINTS IN BOILERS.

To the Editor:—

A paper on "The Best Form of Longitudinal Joint for Boilers," by F. W. Dean, was published in the *Journal* of the American Society of Mechanical Engineers for October, 1909. It recommends as a substitute for the usual form of butt joint in which the outside strap is narrower than the inside one, a joint having the straps of equal width, both to take all rivets and made of sufficient thickness to stand caulking between the widely pitched rivets of the outer row. The author gives an example of a joint of the usual kind, with which an explosion was narrowly averted.

The discussion, which was adverse to the recommended joint, was printed in the *Journal* for March, 1910. The following were the principal arguments against it: (1) According to the customary formulas it is less efficient. (2) It is stiffer, and will cause more injury to the plate outside the joint, by buckling with changes of temperature and pressure. (3) Greater loads are thrown on the rivets of the outer row by caulking on the longer pitch. (4) The tension in the inner butt strap tends to distort it.

Believing that the principles involved, acting as they do, not only in boiler joints but in all riveted and bolted connections, are of such vital importance to life and property as to deserve thorough study, I submit the following comments:

The present formulas used in calculating the strength of these joints are based on at best two serious fallacies: they assume that the shear is distributed evenly among the shearing sections of the rivets, and they assume that the tension is evenly distributed through any longitudinal section of the plates. In the design of joints it should be sought to prevent the stress in any parts of them from being so high as to cause deterioration of the material when subjected to long, continued use under varying loads. If the stress is not so limited, the material loses strength and cracks start. The load is then thrown on some other portion of the joint, which in turn fails, transferring the load still farther until the last, vital section of the metal lets go. If this joint had, when new, been tested in the testing machine, the ductility of the metal would have allowed the different members to yield until a distribution of stress was obtained, which was much nearer that assumed in the formulas. That the assumptions are not even approximately correct is apparent in some of the simpler cases. In the plain lap joint, for example, the bending must produce a tension at the surfaces of the plates in contact several times as great as it would be if evenly distributed, while the opposite surfaces of the plates are probably in slight compression. The heads of the rivets may transfer this locality of maximum stress to a point beyond that of least net section. Thus joints have failed which, according to the usual formulas, were three or four times as strong as necessary. In the more complicated joints the distribution of the shears will depend upon the elasticity of the rivets, the slipping of the plates, and the relative stretch of the plates and the straps. The foregoing will make clear that any comparison of joints by means of these formulas is far from conclusive. (The suggestion is made that much can be learned from the testing machine by measuring distortions of the joints under the loads they are suited to carry.)

In the usual form of butt joint the outer row of rivets exerts a one-sided pull, disturbing the distribution of the stress, and tending to bend the plate just outside the joint. This may be the effect described as the "buckling," which is admitted to be a fault with this joint. It is very difficult to see how mere expansion and contraction of a circular shell could produce buckling. If the writer's view of this is correct, it follows that the symmetrical joint used by Mr. Dean is an improvement. Of course any buckling would show its effects first at the ends of the joint.

The tension due to the cooling of the rivets is undoubtedly more than enough to provide for the loads described in the discussion, and the rivets are probably not subjected to additional tension in either joint.

The change in direction of the circular tension between two rows of rivets is very slight, even in small boilers. The effect on the butt strap is merely that of an eccentric load, most severe midway between the rows of rivets. Obviously its effect is less with the thicker strap, and is very slight compared with the eccentric load thrown on the plate by the outer row of rivets when not supported by the outer butt strap.

The fact may be of interest that a form of joint having an outer strap with its edges scalloped around the rivets of the outer row, is in service on the Danish State Railways.

A study of the faults of the lap joint and the application of the principles to the butt joint must lead one to conclude that the joint described by Mr. Dean is better than that now commonly used.

G. E.

$100,000,000 INCREASE IN WAGES.—President W. C. Brown estimates that the railway wage advances already made or soon to be made will amount to $100,000,000 yearly for the entire country.

ECONOMIC LOSSES DUE TO MINE SUSPENSIONS.

By Eugene McAuliffe.

Much has been said regarding fuel economy. Text books have been written, bought and read; lecturers have discoursed at length on the subject, and in some cases railroads have gone to the expense of equipping or leasing instruction cars, which, manned with a corps of instructors, were moved over the road, giving engineers and firemen a chance to receive oral instruction on this most important subject. Traveling Engineers and their assistants have labored to develop a degree of skill on the part of enginemen, and master mechanics have employed their best efforts in designing front ends, valve motion, compounding systems, and, last of all, the superheater; all with the view of effecting a degree of saving in the fuel account. If this work is not being well done it is because of the pressure of other things. We all realize at least that the field is a fertile one.

While we are battling manfully in the direction referred to, we are asleep, insensible, to greater losses to the fuel account that take place before the coal is put on the locomotive. I refer to the mine suspension, a biennial institution, too mild an affair to deserve the dignity of being called a strike, but which we look forward to as an event to be dreaded, for months, then met in a slam, bang, crash, kind of hurry by buying what we can get, where we can get it, and at what price we can get. If any railroad or large industrial consumer will pause long enough to tabulate their extra coal purchases made in February and March preceding a suspension, the result will provide food for thought. He will find that the prices paid bear *no relation* to the comparative value of the material furnished, often fluctuating as much as twenty-five per cent. in two or three days, this in the case of coal of a common character, coming often from the same mines. If he will compare notes with his neighbor he will find an absolute lack of similarity in prices paid, suggesting that it is not supply and demand that regulates the price making, nor is it cost of production, but rather the ability of the seller to stampede, and the capacity of the buyer to be stampeded, that governs.

Back of this loss comes the other great losses suffered by the operating and traffic ends of the railroad, great enough in the aggregate to stun a whole railroad organization if it were not that the whole calamity is looked upon as inevitable. Among these items might be mentioned the taking out of revenue service coal equipment, a part of which is employed in moving material for building purposes ordered to meet the spring construction period; the rush and hurry of this equipment to mine districts regardless of loading, the clogging of side tracks and terminals on portions of the line due to concentration with consequent loss of efficiency of power, cars and men. In the past sixty days cars have been rushed out of mines without scale weights, the way-bill stamped "weigh en route," cars eventually reaching the storage pile without weights. Pennsylvania steel billet cars with a twelve inch sideboard and with a load of twenty-five tons, billed at a capacity weight of fifty tons, all overlooked in the rush incident to "getting the stuff." It seems farcical for a railroad fuel department or coal producer to work all summer toward securing refinement in weighing and grading coal, only to see several months work broken down in six weeks. Then comes the aftermath, the loading up of coal dumped promiscuously on the ground with a loss for labor, theft, and deterioration in quality, frequently amounting to fifty cents per ton, the breaking down of the operating organization in the mine districts, crews pulled off, weigh-masters and station forces reduced to meet reduction in revenue, all of which must be rebuilt in a few weeks when work resumes and the storage piles are burned up.

It might be well to pause and ask ourselves, Why all this confusion? The last campaign is too fresh in our memories to require a detailed answer, although the struggle has been a bloodless and almost a noiseless one. At the date of publication thirty days from the writing of this communication, the mines will all be at work, at least those which have work to do, some of them idle perhaps waiting for their customers to finish consuming their stock piles.

The coal operators and mine workers in a portion of Pennsylvania, all of Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, Oklahoma and Texas, work under agreements that expire simultaneously, *i. e.*, March 31st; the last one of two years' duration, and made in April and May, 1908, during a suspension varying from three to eleven weeks in length, during which time the railroads and industries, as well as domestic consumers, were supplied from storage piles or by coal moved from the non-union districts of West Virginia, Kentucky, Alabama and Colorado, with a considerable east bound movement from union mines in Wyoming working under a wage scale expiring September 1st. All of this outside coal is bought at the expense of a premium due to long haul and much of it is hauled over the rails of roads consuming it at a material expense to the transportation department; this expense not included in the item of fuel cost as defined by the Interstate Commerce Commission. It does not take a far-seeing man to recognize the great economic loss due to this procedure, and while it is a patent fact that coal brokers and others use the anticipated shutdown for price exploitation purposes, the stable producer of coal who owns and operates mines in the suspended territory is ultimately a loser, due in part to disorganization of working forces and loss of business to the non-union districts, as well as to the fuel oil and natural gas fields, but more so to the fact that during the suspension period and after work is partially resumed his Sales Department, under pressure to get business, frequently takes contracts at a price insufficient to cover the cost of production and maintain and replace the depleted property. In this way the money taken in the shape of premium is lost to the producer, the jobber alone retaining his profit. This conduct spells nothing less than attack and reprisal, and savors more of the Algerian piracy of 1795 than good business methods.

Trade journals magnify these anticipated and recurring troubles, seeking to justify a line of business conduct that is in the long run neither defensible or profitable. There is no doubt but that the average price paid for coal in the Mississippi Valley field has for some years been too low, this due to an excess production, the price fixed by a minority of the producers, but necessarily governing the whole. What the coal trade wants is an earnest effort to eliminate the conditions attendant on the making of wage scales that serve to cover the abuses referred to, and the money lost by the consumer in storing and hauling coal would, I am sure, be willingly paid to the producer if the proper presentation was made, at least by the railroads who are certainly managed by men of sufficient foresight to see that the wreck of an industry as important as this is, means an ultimate loss to the railroad.

The writer has been asked, in what direction does the remedy lie? He is a poor student of the times who does not recognize the fact that in the case of industrial disputes, whether transportation, manufacturing or mining, the greatest sufferer, and the one who is least considered, is the public, the great mass who depend on the industry for some facility or commodity. What the people want to insure industrial peace is "the lime-light," a poor cause will then yield to that most potent ultimate force, public opinion—a jury trial—the public the judge. Let the operators and the mine workers cease making contracts to expire at a given date, instead make them subject to cancellation on thirty days' notice on the part of either subscriber, with a clause providing that operation will be continued for ninety days after cancellation and pending the negotiation of a new wage scale. Supplement this arrangement with an effort to secure the passage of an arbitration act either an amplification of the Erdman act covering disputes incident to interstate transportation, making it applicable to all industries, or, better still, secure an act patterned after the Canadian Act, which, since its enactment three years ago, has resulted in a condition well covered by the following letter written under date of August 31, 1909, by the Honorable MacKenzie King, Minister of Labor of the Dominion of Canada:

"Having just returned from New York, I find your communication of the 26th inst., requesting information in regard to our Industrial Disputes Investigation Act.

"I have asked the Deputy Minister to forward you copies of the measure, and also information in regard to the workings of the Act, which I think may be of service to you.

"In the September number of *McClure's Magazine* you will find an interesting article by Dr. Eliot, President Emeritus of Harvard University, dealing with the workings of the Act during the first two years of its existence.

"I regret to say that so far as coal mines are concerned, the Act has not been entirely successful in averting all industrial disputes. In connection with the agencies of transportation, such as railways, telegraphs, street railways, etc., it has given the country an all but complete immunity from the cessation of industrial operations for a period of nearly two years and a half; in connection with mines, it has averted some strikes entirely, and in almost all cases has prevented a sudden cessation of operations.

"There have been, however, cases in which one or other of the parties, not being satisfied with the awards of Boards, have endeavored to enforce their demands by the old weapon of the strike; most of such strikes have been concerned, primarily, with the question of union recognition. Where the question has been one, rather, of conditions of employment, the Act has been of almost as great service in connection with mines as in the case of disputes in other industries.

"I hope you will find the reports, which are being forwarded, of some service."

With a view of making further explanation of the workings of this beneficent act, I quote in part from the article written by Charles W. Eliot, President Emeritus of Harvard University, published in *McClure's Magazine* of September, 1909, and referred to by Mr. King:

"The chief feature of the beneficent Canadian Act, called the Industrial Disputes Investigation Act, was the requirement that, in the event of a dispute arising in any industry known as a public utility, it should be illegal to resort to a strike or lockout until the matters in dispute had been made the subject of an investigation before a Board of Conciliation and Investigation, to be established under specified rules by the Canadian Minister of Labor. Under this Act, either party to a dispute may apply for the appointment of a Board of Investigation. Each of the two parties to the dispute may nominate one member of the Board, and these two may select the third, who serves as chairman of the Board of three. If either party fails to nominate a member, the Minister of Labor appoints that member, and if the two members fail to agree upon the third member the Minister appoints the third member. The Board will therefore inevitably be constituted, and will go to work, if either party to the dispute applies for an investigation. The proceedings of every Board appointed and its final report are published throughout the Dominion in the most complete manner.

"During the two years from March 22, 1907, to the end of March, 1909, fifty-five applications were received for the appointment of Boards, under which forty-nine Boards were set up. In the remaining six cases the disputes were settled, either during the discussion arising out of the application, or during the formation of the Board; but these six cases of prompt settlement are obviously due to the influence of the Act—that is, to the prospect of complete publicity with regard to the causes of the dispute and the claims of the disputants. The fifty-five applications were distributed as follows: Concerning mines and smelters, 30; concerning transportation, or means of communication, 23; concerning disputes in industries which were not public utilities, 2. In these two cases both parties to the industrial dispute applied for an investigation, the Act providing that its benefits may be extended to industries other than public utilities, if both parties, instead of only one, make application for the establishment of a Board.

"On the fifty-five applications received, strikes were avoided or ended in twenty-five coal mines, and four metalliferous mines, in fifteen railroads and three street railways; in two bodies of longshoremen, in one body of teamsters, and in one body of sailors, and in two industries not public utilities. There were two cases in which strikes were not averted or ended. Only two cases, therefore, out of fifty-five utimately resulted in strikes, these two strikes being in perfect accordance with the wise terms of the Act, which permit owners to lock out their men and workmen to strike after the public investigation has been completed and its results published.

"The official reports (see the *Labor Gazette*, issued monthly by the Department of Labor, Ottawa, April, 1909, pp. 1080-91) make it plain that some of these disputes were serious, affecting directly large numbers of persons and indirectly threatening the common welfare. Among the strikes in mines may be mentioned that on the Cumberland Coal Company, with 1,700 men concerned; that on the Crow's Nest Pass Coal Company, in which 1,800 men were involved; that on the Dominion Coal Company, January 4, 1908, with 7,000 men affected; that on the Nova Scotia Steel and Coal Company, with 1,750 men affected, and that on the Dominion Coal Company on March 4, 1909, with 3,000 men affected.

"To the question whether the Industrial Disputes Investigation Act has been effective the clear answer is that since its enactment, in March, 1907, the Dominion has known no cessation in the continuous operation of any of its great agencies of communication—steam railways, electric railways, telegraph and telephone lines, or other public utilities of the kind—and the national industries and the public have not suffered any inconveniences other than a few of a purely temporary and local nature through the cessation of some mining operations. This remarkable record may not be continuously maintained; but it seems quite possible that never again will the interests of the Canadian public be injured through the threatening or actual outbreak of sudden and extensive industrial conflicts, such as frequently occurred in Canada prior to the enactment of the law, and still occur, with enormous and widespread damage, in the United States."

The investigation of this act by Mr. Eliot, a man of recognized character as a student of economics, suggests that we, as a people, are sadly in need of some similar legislation. A strike is war, getting ready for one that may not come is a crime, and it is time to call a halt. For the past three months the managers of four score of railroads have worked to settle wage disputes—arbitration was the weapon used; if these gentlemen will give one-fourth of the effort spent by them in the past winter on this other wage question, the abolition of the stock pile as an insurance against coal strikes will be accomplished, and with a proper presentation, the responsible coal operator will be glad to join forces to accomplish this end.

A FIELD FOR THE PRODUCER-GAS POWER PLANT.

In the United States cheaper power is constantly sought. The water-power possibilities of the country are being realized and the hydro-electric power plant is a wholesome cause of competition. The supply of fuel of marketable grades is not unlimited. Prices for such fuel must of necessity increase. The cost of transporting coal from the mines is high, and the possibility of obtaining a sufficient supply of cars to handle low-grade fuels is questionable. The power demands of the country are increasing, and this power must be developed at a reasonable cost. The time is approaching when the cheapest fuel obtainable must be used to the best economic advantage in order to develop power at a unit cost consistent with commercial progress.

Consideration of the conditions indicates that in order to keep the price of power developed from fuel down to a consistent figure—

(*a*) Grades of fuel which warrant transportation, or which may be defined as "marketable," should be used with the greatest practicable economy.

(*b*) The very large percentage of coal of so-called low grade which to-day is left at or in the mine must be utilized.

(*c*) Advantage must be taken of the large deposits of lignite and peat which are found in many sections of the country.

It is undoubtedly true that in general, under conditions which do not require the use of steam for other than power purposes, the producer-gas power plant meets the requirements of (*a*).

At present the only method of advantageously handling the fuels mentioned in (*b*) and (*c*) is in the gas producer, and the utilization of these lower grades of fuel on an extensive scale demands concentration of the power plants within close proximity to the fuel supply.

The logical conclusion from a careful study of the producer-gas power situation is that the time is not distant when financial interests in power production will be directed toward the centralization of the producer-gas power plant at the mines and the distribution of the energy developed either by high-voltage long-distance electrical transmission or by pipe systems for conveying the gas.—*From Bulletin 416 on "Recent Development of the Producer-Gas Power Plant in the United States," by R. N. Fernald, issued by the U. S. Geological Survey.*

COST OF HANDLING LOCOMOTIVE FUEL SUPPLY.

A DETAILED INVESTIGATION AND DISCUSSION OF THE VARIOUS ITEMS THAT MAKE UP THE COST OF TRANSFERRING COAL FROM THE MINE SIDING TO THE LOCOMOTIVE TENDER.

By Raffe Emerson.

[Editor's note.—In the Railway Number of Cassier's Magazine (March, 1910,) Mr. Emerson presented an article under the title of "Railway Fuel Supply," of which the following is a liberal extract, presented by the permission of the publishers.]

One-quarter of the coal mined on the North American continent is used by its railways, the 60,000 locomotives in the United States alone taking over one hundred million tons each year at a rising price (1909, about $2 per short ton).

This expense for locomotive fuel is practically a tax of one cent a day on every man, woman and child in the country. Any means for reducing this growing cost, in however small degree, is worthy of the interest, attention and consideration of all the people as citizens, as well as of statesmen, financiers, economists, railroad men and engineers.

Five per cent. of this huge fuel bill (that literally consumes nearly the hundredth part of the people's wealth every year) is a charge against it that does not add in any material way to the fuel value of the coal burned, but rather the reverse, namely, the cost of loading this fuel onto locomotive tenders out of cars from the mines. This expense averages fully twice what it demonstratedly should be (could be, and in places *is*), and its reduction, through the use of efficient modern types of fueling stations, would bring about as correlative benefits a great decrease in the amount of human labor now spent in the dirtiest, most back-breaking toil, and would also eliminate much crumbling and deterioration of the coal from unnecessary handling.

To load fuel on locomotives costs roughly 8 cents a ton, the average being more nearly 10 cents. In actual instances it may get under 4 or 5 cents, and I firmly believe that a figure between 1 and 2 cents is not chimerical to hope for, nor an average figure of 3 cents a ton, covering all direct costs including interest and depreciation, an unreasonable expectation for the developments of the next year.

The present average charge is about as follows:

	Cents per Ton to be Handled.
Interest and depreciation	3.0
Maintenance	1.0
Labor	6.0
Supplies	0.0
	10.0

Discussing these items in turn, we find that the interest and depreciation depend principally on the capacity of the fueling station in tons handled per day, for a given investment, and secondarily upon the durability of the structure and apparatus. The following table shows the interest and depreciation, figured at three rates in fueling plants per ton capacity per day. This

Investment per Ton Daily Capacity, Dollars.	Interest and Depreciation in Cents per Ton Loaded on Locomotive at a Rate Yearly of 8 Per Cent.	12 Per Cent.	20 Per Cent.
5	.1	.2	.3
10	.2	.3	.6
20	.4	.7	1.1
30	.7	1.0	**1.7**
40	.9	1.3	2.2
50	1.1	1.7	2.8
60	1.3	2.0	3.3
70	1.6	**2.3**	3.9
80	1.8	2.6	4.4
90	2.0	3.0	5.0
100	2.2	3.3	8.3
120	**2.7**	4.0	6.7
150	3.3	5.0	5.6
200	4.4	6.7	11.1

table makes it very easy to determine the amount to add to the cost of handling fuel in order to arrive at the full cost per ton including interest and depreciation at a given rate. The investment cost of the fueling station is divided by the average daily tonnage issued to locomotives, giving "investment per ton capacity," and the intersection of this line, with the selected "Interest and Depreciation" column, gives the cost per ton of the latter.

The figures between the heavy lines indicate usual ranges, and the heavy-face figures what may be considered good standard practice. From this table a very simple rule governing fuel station investment, or investment in fueling station improvements, may be derived.

Find the cost per ton of the interest and depreciation charge on the proposed investment and see whether it is substantially less than the saving in handling cost effectably by making the investment.

The durability of the station and accessories also affects the maintenance charge to a large degree. In this charge probably the "fire risk" should be properly included. In a modern station the maintenance should be low—less than 1 cent per ton handled, ¼ cent being an entirely practical and attainable figure.

	Cost per Ton in Cents. Minimum.	Average.	Maximum.
Unloading from car	0.03	2	10
Operating fuel station	0.1	1	5
Loading on engine	0.2	3	15
Total	0.3	6	30

Labor may be subdivided into elementary operations (sometimes combined, or still further subdivided) as indicated by the preceding table.

An automatic balanced bucket type of fueling station, served by the very best self-clearing coal cars, handling 250 tons in twenty-four hours, and using the services of one man but half a day, coal being taken by gravity by the locomotive firemen, would give the minimum cost above indicated.

Supplies are a considerable item only in mechanical or power crane or hoist-drum types or station. This charge will run from practically nothing to 1 or 2 cents per ton, according to fuel or power used. Properly to be considered in this item, although not so charged in the Inter-State Commerce Commission's Official Classification of Railroad Accounts, is the cost of switching service, placing cars on trestles, setting them, withdrawing empties, etc. This service is worth about $2 per hour, and as an average yard locomotive will handle from two to twenty cars per hour, in or out (average about six, allowing for locomotive in service day and night), the cost per ton will be about ½ cent to about 5 cents, and an average about 2 cents per ton.

Three mighty important aspects of this problem, amounting to a much greater money value than the entire cost of handling the fuel, direct and indirect, are usually but little considered, because railway accounts are kept to show money expenditure rather than time expenditure, notwithstanding that in transportation, in the use of equipment—cars, locomotives—for handling a volume of traffic, *time is money*. These three aspects are:

Detention of locomotives for coaling;

Detention of coal cars for unloading;

Transportation cost of company's supply fuel in cars over company's own lines (such freight charges being over foreign or other lines about one-half of the average $2 per ton cost of railway fuel).

A fourth item of great importance, which may equal or perhaps exceed the handling charge, is the deterioration and crumbling of the coal, due to the way it is handled and re-handled.

These four large items of correlative cost, affected by the way the fuel is handled at the fueling station, range about as follows (locomotives are worth in earning power from about twenty to *several hundred* dollars per day; an average tenderload of coal will be from 4 to 15 tons, say about 7.)

(Cars earn from $1 to about $10 per day, average being about $3.)

Locomotive Detention in Minutes.	Value of Locomotive Time in Earning Power, per Detention per Ton of Coal Loaded. Values in Cents.		
	Minimum.	Average.	Maximum.
Minimum: 1	0.1	0.8	5.0+
Average: 12	1.0	9.0	50.0+
Maximum: 6 hours	25.0	$3.00	$30.00+

Car Detention for Unloading.	Value of Time in Cents per Day Detention per Ton of Coal Unloaded.		
	Minimum.	Average.	Maximum.
Minimum: 10 min. +	...	0.5	0.25
Average: 8 days	16.0	60.0	$3.00
Maximum: 20 days +	40.0	$1.50	$10.00

Cost of transportation will vary from less than 0.1 cent per commodity ton mile to over 3 cents, and average about 0.3 cent. Taking the average figure, the following table gives the cost of hauling railway fuel per ton of fuel for distances one mile tc one thousand miles:

AVERAGE COST OF HAULING ONE TON OF COAL, IN DOLLARS.

Miles.	Cost.	Miles.	Cost.	Miles.	Cost.
1	$0.003	10	$0.03	100	$0.30
2	.006	20	.06	200	.60
3	.009	30	.09	300	.90
4	.012	40	.12	400	1.20
5	.015	50	.15	500	1.50
6	.018	60	.18	600	1.80
7	.021	70	.21	700	2.10
8	.024	80	.24	800	2.40
9	.027	90	.27	900	2.70
10	.030	100	.30	1000	3.00

The relation of fuel value to economical transportation zone has been elaborately developed in a thoroughly practical way by Mr. Crawford, of the Chicago, Burlington & Quincy Railroad, and those interested are referred to his paper before the Western Railway Club of Chicago.*

"Run-of-mine" coal is generally bought for locomotive use, both because it is cheaper per ton and because its purchase helps the mine operator to dispose of an otherwise often unmarketable product (this policy being a practical conservation measure). "Run-of-mine" will "run" 25 to 60 per cent. of slack, the average being over 35 per cent. "Run-of-mine" is priced from 10 to 30 cents per ton less than screened coal. Each per cent. of slack is therefore worth a price difference of about ½ cent. Every handling of the coal will result in a breakage or crumbling of one to three per cent., and will run as high as eight per cent. with some types of mechanical plants. As each ton of coal is handled from one to three or more times from car to tender, averaging twice, the deterioration in value due to crumbling amounts to from ½ cent to 4 or 5 cents a ton, averaging between 1 and 2 cents.

The reduction in steaming capacity will be about half of the cinder percentage—thus 10 per cent. cinders will reduce the locomotive efficiency by about 5 per cent. compared with the use of a cinderless fuel. As the locomotive is worth from twenty to several hundred dollars per day earning capacity, the reduction of capacity due to cinders ranges in value from 50 cents to $40 or $50 per day. On a fuel consumption per locomotive of from 4 to 20 tons per day this loss in steaming or hauling efficiency is equivalent to from 10 cents to $4 per ton of coal fired, averaging about 50 cents. Putting it another way, each per cent. added to the slack means a reduction in earning capacity of the locomotive about 2 cents per ton of coal fired, beside an average loss of unburned fuel itself of another cent per ton per 1 per cent. of slack.

To restate: Each handling of the coal causes an addition to the slack of about 2 per cent., which results in fuel and efficiency losses of about 55 cents per ton. These losses are as low as 12 cents and as high as $4 per ton handled. These figures are given at considerable length to demonstrate the great desirability of designing coal-handling appliances, so that the coal will suffer the least possible crumbling.

* See AMERICAN ENGINEER, April, 1908, page 124

The controlling factors in handling fuel on railways have been stated and developed, and may now be summarized:

Fuel for locomotive supply costs at the mine 75 cents to over $3 per ton, averaging but slightly over $1.

Freight charges over *other* ("foreign") lines range from nothing to about $3, and average slightly under $1 per ton.

Cost of transportation over company's own lines ranges from nothing to about $5 per ton, averaging roughly 40 cents.

Time on cars at mines and in transit is valued at from a minimum of about 3 cents per ton to over $5, averaging some 60 cents.

Empty car movement entails a further transportation cost of 35 cents a ton average, ranging up to $3.

Car detention at fueling station ranges from practically nothing to $10 per ton, averaging 60 cents.

Switching service at the fuel station costs from ½ cents to 5 cents per ton, the average being 2 cents.

Labor handling fuel at fueling stations ranges from 0.3 to 30 cents per ton, averaging 6 cents.

Power and supplies for fueling station, from nothing to 3 cents per ton, averaging about 2 cents.

Maintenance of fueling station, from 0.1 to 2 cents per ton, averaging a little over 1 cent.

Interest and depreciation on fueling station, from 0.4 to about 6 cents per ton, averaging about 3 cents.

Taxes, ground rent, supervision and other general charges, from 0.1 to about 0.3, average about 0.1.

Detention of locomotives being coaled, 0.1 cents per ton coaled, to $30, average about 9 cents.

Loss of fuel value and locomotive efficiency from crumbling due to handling, from 12 cents to $4, average over 50 cents.

SUMMARY OF LOCOMOTIVE FUEL COSTS PER TON.

Order of Importance.	Item.	Average Per Cent. of Cost.	Minimum, Cents.	Average, Dollars.	Maximum, Dollars.
2	Price at mine	24	75	$1.10	$3.00
3	Freight	19	0	.90	3.00
5	Transportation	9	0	.40	5.00
1	Use of transportation	32	4	1.50	18.00
8	Switching	0	0	.02	.05
7	Total fuel station	2	1	.10	.35
6	Locomotive detention	2	0	.09	30.00
4	Unnecessary slack	12	12	.55	4.00
	Total	100%	92c.	$4.66	$63.40

By the above table it is seen that the most important consideration in railway fuel supply is the location of the source of the supply, with reference to the principal fueling stations where the supply is delivered to locomotives, and the efficient movement that is given to its transit.

The next consideration is price, relative to quantity (*i. e.*, per cent. of slack and sulphur). The last consideration is fuel station operating efficiency, including promptness of loading engines; Indeed this last factor may overshadow all others in money value, becoming ten times all other costs, including purchase price of fuel put together. Under circumstances where engine time is of great value (almost invariably the case where the engines are assigned to a "pool" or to "rounds"), the presence of a coaling station of the most modern type, coaling the engine with the greatest expedition and with the least injury of the fuel, becomes a transportation necessity.

The main features controlling design are:

1. Daily capacity required.
2. Is ground storage feasible or desired?
3. Terminal station or isolated plant.
4. Location.
5. Kind of car used.
6. Release of cars.
7. Switching.
8. Number of tracks served and clearances.
9. Kind of construction and fire risk and protection.
10. Installation or desirability of weighing or measuring apparatus.
11. Combination fueling operation with ashing, watering and sanding, in one station, and with one engine movement.

12. Kinds of fuel used, whether mixed, and preparation required.

13. Power available.

The variations in detail of design, the different combinations of elements of design, are so many and so varied, that no description or classification of the existing types will be attempted here. But the underlying elements of railway fueling stations may be outlined; such a station consists of:

A track or tracks (siding) for (a) reception of cars of coal; (b) holding of cars of coal; (c) unloading of cars of coal.

Cars with supply of coal; reservoir for coal storage (ground or bin); main and auxiliary; track or tracks for engine supply; intermediary to supply coal to engines from reservoir (or from cars). All fueling stations combine these elements in varying degree.

In conclusion it may be repeated that the several items, both direct and indirect, affecting locomotive fuel cost aggregate about $5 per ton, or about five times as much as the price of the fuel at the mine, although an attainable minimum of $1 per ton is indicated. The type and operation of the fueling station may affect this cost (indirectly rather than directly, as in saving locomotive time in coaling, or handling coal without crumbling) in very marked degree, and is worthy of the most serious study and attention. But little of definite value in the way of information upon which to base conclusions and make decisions can be secured without adequate records, complete as to detail, comprehensive as to interaction of all the various factors to be considered.

The installation of complete *records* of all the items of fuel cost here considered will yield far more instructive and valuable results in the reduction of railway fuel expense than an equal amount of money spent in any other way. The return is actually over 100 to 1.

OLD AGE PENSIONS.—In 1907 a Commission on Old Age Pensions was appointed in Massachusetts to study the various systems devised in other countries and in use among industrial and railroad corporations. Its report in a volume of 500 pages has lately been published. From a summary printed in the Boston *Transcript* the inference is drawn that its work has been thorough and valuable. The committee came out strongly against any scheme of non-contributing old age pensions, such as the one lately introduced in Great Britain. This it condemns on the score of expense, of discouragement of thrift, of a disintegrating effect upon the family, and of an unfavorable influence upon the rate of wages. Yet a plan of contributory retiring pensions for public employees, including those of towns and cities, is emphatically recommended by the committee, and the scheme of retiring allowances for aged workmen is urged upon large employers of labor, the whole to be based squarely upon the contributory principle. In line with this vigorous and wholesome assertion of the duty of self-reliance, is the recommendation that "thrift should be included among the subjects of compulsory instruction in the public schools."

THE HEALTHIEST TRADE.—Compilations have been made, from Government reports, showing the relative liability to disease of the employees in various trades. According to the returns so far tabulated by the Census Bureau, the occupation of the steam railroad employee is the healthiest of all. In a long list of maladies, the only one to which the railroad employee is more liable than workers in manufacturing or agricultural trades is typhoid fever, and to this he is far less liable than are the workers classed as "laborers." The figures show that the railroad man is far less liable to consumption than the workers in the manufacturing and mechanical industries. He is less apt to commit suicide than any other wage earner, and suffers less from rheumatism and malarial fever. His nervous system, according to the statistics, is in excellent shape. Heart disease and pneumonia are rarer among railroad employees.

SAFE SPEEDS FOR CAST IRON FLYWHEELS.*

The speed at which a flywheel may be safely run depends upon the material of which it is constructed, upon its design, and upon the conditions under which it is used.

The relative fitness of various materials for flywheel rims is measured by dividing the tensile strength T per unit of area, by the weight W per unit of volume. The higher the value of T/W, the better is the material fitted for use in a flywheel rim. The strength of the rim of a flywheel to resist centrifugal force cannot be doubled by doubling the quantity of material in the rim, because the centrifugal force is doubled also when the quantity of material is doubled. It results then, that for any given material, the strength to resist centrifugal force does not depend upon the quantity of material in the rim, but only upon the tensile strength of that material, and for any given material in a flywheel rim there is a definite rim speed or velocity that cannot be safely exceeded.

The formula for determining the safe rim speed of flywheels is as follows:

$$V = 97.8\sqrt{\frac{T}{W} \times \frac{E}{F}}$$

in which

V = Safe rim speed in feet per minute,
T = Ultimate tensile strength of material in flywheel rim in pounds per square inch,
W = Weight of material in flywheel rim in pounds per cubic inch,
E = Efficiency of joints in flywheel rim,
F = Factor of safety.

In the case of cast iron, an ultimate tensile strength of 10,000 pounds per square inch is as much, probably, as can be assumed with safety. If then a factor of safety of 10 be taken in a wheel with a solid rim, the formula becomes (E being equal to 1 since there are no joints):

$$V = 97.8\sqrt{\frac{10{,}000}{0.26} \times \frac{1}{10}}$$

or 6,060 feet per minute. That is to say, the safe rim speed for a cast-iron wheel made in one piece does not much exceed a mile a minute. More accurately, a cast-iron wheel, made in one piece and well proportioned, reaches the limit of safety at a rim speed of 1.15 mile per minute.

But if there are joints in the rim of a flywheel, the factor of safety becomes considerably less than 10. Thus, if the efficiency of the joint is only 50 per cent. of the solid metal, the factor of safety in a cast-iron wheel run at a rim speed of 6,060 feet per minute is only 5, and if the efficiency of the joint is only 25 per cent. of the solid metal, the factor of safety is only 2½.

The subject of rim joints is worthy of much more study and experiment than has been given to it. It is to be borne in mind that

$$V = 3.14 \times D \times N$$

in which.

V = Rim speed in feet per minute,
D = Diameter of wheel in feet,
N = Number of revolutions per minute.

The stress, due to centrifugal force, in the rim of a flywheel made of any material whatever, and also the bursting speed, may be obtained from the following formulas:

$$P = \frac{W \times V^2}{2.66} \qquad B = 1.63\sqrt{\frac{T \times E}{W}}$$

in which

P = Stress in pounds per square inch,
V = Rim speed in feet per second,
B = Rim speed in feet per second at which disruption will occur,
T = Tensile strength of the material in pounds per square inch,
W = Weight in pounds per cubic inch,
E = Efficiency of the rim joint.

By placing the maintenance of belting in the hands of a specialist, with instructions to prevent failures, not remedy them, and to use only the best quality of material for repairs and renewals, the belting expense in a large railroad shop decreased from $1,000 to $300 per month and the number of failures from 300 to 55 in about 15 months. The conditions before this was done were not worse than in many other railroad shops.

* From the Fidelity and Casualty Company's book on "The Prevention of Industrial Accidents."

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CONTENTS

It is with pleasure that we announce the addition to our editorial staff of Oscar Kuenzel.

Mr. Kuenzel is a graduate, in mechanical engineering, of Ohio State University and started his railroad career with the Pennsylvania Lines West of Pittsburgh in the summer of 1903. He finished his special apprenticeship in 1907 at the Columbus shop and in June, 1908, was made acting assistant master mechanic of this shop. In February, 1909, he was transferred to the office of superintendent of motive power of the Southwest System, where he has been engaged upon special work in connection with the design of new shops, engine house facilities, reports on new locomotive appliances and systems and methods of handling repairs.

Mr. Kuenzel will devote the major portion of his time to shop and machine tool articles, for which his experience has particularly well fitted him.

The conclusions following a detailed individual inspection of over 1,600 locomotives on one of our largest railroad systems, which extends through a typical section, traversing both mountainous and level country, are being given by R. H. Rogers in his article entitled "A General Locomotive Inspection," which will be presented in three parts. The opportunities offered by such an inspection are exceptional and we consider ourselves fortunate in being able to give our readers the benefit of this experience.

THE FUEL DEPARTMENT.

Practically all appliances that are invented for locomotives base their claim for recognition upon their direct or indirect ability to save fuel. The proof that an appliance will save a ton of coal a day can be formed into a very convincing argument for its general application, and in fact most of the new appliances or new designs of locomotives have come into general use largely because of their fuel-saving ability. Every one recognizes the enormous money value of a small saving on the fuel consumption of each locomotive and every one will take the time to carefully consider any device which promises results in this direction.

In view of this, it seems inconsistent that so few railroad companies have a thoroughly organized and efficient fuel department, which beyond doubt, by its mere ability to discover unnecessary losses, will be able to show a net saving that will far exceed the saving of all the different appliances that could possibly be put on to a locomotive. There are very few railroad systems which do not offer a field for a complete and even elaborate fuel department. Where such a department has been organized it has brought to light entirely unsuspected leaks and been able to institute economies in unthought of directions that often much more than pay its total expense.

A large section of this issue is given up to an outline description of the fuel department of the Atcheson, Topeka & Santa Fe Railroad, which, while it is not yet complete nor by any means perfected, is probably organized on a broader basis and is more efficient than that on any other system in this country. This department was able to very quickly show that it was by no means a luxury or a fad. It delivered results from the very beginning that were particularly gratifying to the management and has continued to better its records in this regard every month.

The secret of the results that are being obtained lies very largely in two things: first, personnel, and second, methods. The largest factor in the latter is the designing of a system of reports and of records which will give the maximum amount of really valuable information with the minimum delay and the least amount of clerical work. Having drawn up a suitable series of forms for reports and records a very large part of the foundation of the department has been finished. If these are suited to the conditions in every respect and are in charge of properly qualified officers, the success of the department is practically assured at the start.

A GENERAL LOCOMOTIVE INSPECTION.

AN ACCOUNT OF THE METHOD OF PROCEDURE, SOME OF THE RESULTS AND THE CONCLUSIONS FOLLOWING A DETAILED INDIVIDUAL INSPECTION OF OVER FIFTEEN HUNDRED LOCOMOTIVES OF ALL TYPES AND SIZES.

By R. H. Rogers.

IN THREE PARTS. PART I—SCOPE AND METHODS.

In September, 1908, it was decided by the management of one of the large railroad systems (hereafter called the A. B. C. R. R.) to have a special inspection made of each and every locomotive owned or leased by that system, and the writer, through its general mechanical superintendent, was deputed for the work. The assignment was formidable, as the fifteen hundred and odd engines were scattered over one thousand miles of straight main line and on diversified branches, which brought the total mileage to 2,406 miles. The number of divisions, each under a master mechanic, was twelve; but the roundhouses which must be visited incidental to the inspection aggregated forty-four, not to mention some dozen or more isolated points without roundhouse facilities, but where nevertheless switching and work train engines were employed.

The reasons which prompted the inspection have never been entirely clear to the writer. It was on a scale of such magnitude as to render the procedure practically without a precedent, and it is unfortunate through this singularity alone that the motive is obscure. It has been suggested that the thought arose primarily through a criticism offered by one of the outside building shops, following an instance where the railroad company objected to an excessive bill for repairs to some of its engines. This building shop, in excuse or explanation, is said to have advanced that the high cost was due to the fact that the engines were in a distressingly run down condition when received at the works, worse in this regard than any repairs heretofore contracted for. This is supposed to have rankled the management to the extent that an inspection for self-advisement logically followed.

Although with merely speculation as a basis the writer does not think that the unique assignment was so inspired. The power, as a whole, on the A. B. C. Railroad had for some time previous been the subject of much unjust oral and written criticism, and the portrayal of presumed conditions through the latter medium embodied an equal mixture of aspersion and levity. It was erroneously asserted, or at least implied, that the engines were generally unserviceable, and that the unfortunate schedule irregularities of the period were due more to their poor condition than any other cause. It is therefore the belief of the inspector that to disprove this clamor, or at least satisfy himself through a disinterested observer, the general mechanical superintendent determined to have each locomotive carefully examined, although it was self-evident that several months at least must be consumed in the undertaking. The thought is also present that he wished to know personally how the locomotives of the A. B. C. Railroad compared with those of other large roads with which the inspector had been connected in the past.

It is fitting to say here that no matter who or what may have dictated the inspection, the attitude of this official throughout implied simply the desire to get at the facts, whether detrimental to his administration or the reverse, and his encouragement and appreciation extended from time to time as the rather trying assignment progressed, served to temper many a weary day with its accompaniment of ice bound ash pits and the gloomy and damp environment of roundhouses in the dead of the winter season.

The general conclusions reached in the final report of the inspection, independent of the motives which brought it about, must have been gratifying to the management of the A. B. C. Railroad. In fact, long before the wind up, the reports which reached the general offices weekly from the inspector on the line had steadily developed the fact that far from being inefficient, the general run of the locomotives were above the average of efficiency. In fact, the recapitulation of all reports submitted showed an even seventy-eight per cent. of the total power as efficient. This, it may be added, was four points higher than in the instance of two other large systems whereon the writer was connected with a somewhat similar inspection. It was an eminently fair summary, as the inspector was an entire stranger to the road and its division management, and through this unfamiliarity had not a single axe to grind. He was paid merely to narrate conditions as they appeared to him, and the freedom was allowed, or at least not objected to in his reports, to draw whatever inferences might suggest from the notes at hand.

In order that freedom from the slightest imputation of unfairness be assured in connection with the inspection, certain requisites were self-evident for the person selected to make it. Primarily, it was appreciated that he should not be identified with any division of the A. B. C. Railroad, as absolute impartiality must prevail in his reports to endow them with the comparative value per division, which was especially desired, and he must necessarily have thorough familiarity with locomotive conditions as they should be for efficiency, in addition to possessing a general knowledge of up-to-date practises in repairs to parts.

The first, and most difficult of these conditions, was happily realized in the instance of the writer, who, previous to the assignment, had traveled but sixteen miles over this railroad, and had yet to see the first of its shops or roundhouses. He was equally unacquainted with the supervision of any shop, or its workmen, on each of the various divisions from the first to the last, and unfamiliar with the power as well, except in the instance of a dozen or more A. B. C. engines which had been sent for general repairs to one of the outside locomotive building shops where he happened to be stationed as inspector. This general unfamiliarity with the situation, no doubt, appealed to the A. B. C. management through its implied assurance of fairness, and this latter was, of course, the great end to be desired. In the very brief instructions given before starting out it was plainly apparent that all desired in his reports was a comparison between a locomotive as it should be with existing locomotive conditions on the A. B. C. Railroad, the conclusions to be voiced without fear or favor.

Naturally the inspection, conducted under the favorable auspices of absolute freedom from interference with the inspector, which the management faithfully observed from start to finish, resulted in bringing to light a wealth of interesting detail. The continuous examination of over fifteen hundred locomotives served to establish truisms for many speculations which had before prevailed in accounting for the wear of parts. In view of the well ordered organization of the present day, from which by no means was the A. B. C. Railroad exempt, it is astonishing that there could be so much diversity in locomotive deterioration which its respective divisions exhibited, and the inspection not only established the presence of divergent mechanical procedure, but brought to light as well singular and unsuspected personal features in connection with locomotive maintenance. It is thought advisable, however, to confine this particular article to an explanation of the ends intended by the inspection, and of the plan decided upon to report its details, reserving what was found while on the road, and its lessons, for subsequent presentations.

The consideration of forms on which to report the condition of the various engines examined was abandoned practically in the incipiency of the idea. It was rightly viewed that these, no matter how elaborate in scope, or in multiplicity of items, would not graphically portray the conditions, and furthermore would naturally tend to restrict the inspector's inquiry to their several items. In fact, after the inspection had been completed, the general mechanical superintendent explained that it had been his particular desire for the inspector to assume the initiative throughout. This serves to explain the absence of forms, or report blanks, and to account for the brevity of the original assignment, which was practically without instructions.

As a preliminary to starting the work two problems were presented which must necessarily be solved before the first locomotive was looked over and reported on, this in order that uniformity be secured through the entire bulk of reports, and no move was made until these had been decided upon. It was readily appreciated that there could be no deviation from a procedure once inaugurated. The first of these, which became the subject of much reflection, was how best to report each separate engine, as routine reports or forms were tabooed; and second, how to broadly define the general condition of each locomotive on the reports for the information of the mechanical superintendent, and for use in the final summary of each division.

In the consideration of the first item it was assumed that a detail inspection report, such as a roundhouse inspector would return to his superior, was out of the question, and this largely because the reports of a general inspection must be made to the head of the motive power department direct, who through the demand on his time should not be burdened with the review of nuts off bolts, or cotters lost from brake rigging pins. Not disputing that these reports are indispensable in roundhouse organization, they were not considered of sufficient importance in this connection to warrant presentation, hence it became a requisite to evolve a scheme for the conduct of this inspection on broader and more significant lines than are employed in roundhouse or local procedure.

It was resolved to confine strictly to what implies locomotive deterioration in its true application; that is, the features of deterioration which are practically beyond the resources of an ordinary roundhouse to correct, or if not beyond it, are still through time-honored precedent, allowed to remain in evidence until the engine must be taken in for general repairs. From this viewpoint the inspection must then omit the smaller items in need of repair, notwithstanding in many instances that it effectually indicated the crying need for a remedy.

It was concluded, or assumed by the inspector, that such minor detrimental conditions as a rod brass in need of reducing; a driving spring rubbing the fire-box; an injector branch pipe leaking, or a tank hose requiring a new nut, would be reached and corrected in due season by the roundhouse foreman. Through the same reasoning it did not appeal as necessary to mention blows in valves or cylinder packing, or even comment on engines with valves out of square, as, properly viewed, none of these are active elements in deterioration, because they must perforce be immediately corrected in recognition of the conceded locomotive inefficiency present under such conditions.

In the interest of harmony and good feeling the inspector decided after due reflection to make direct mention of such items to the division supervision in the territory where they were noticed, and their omission from his report to the general mechanical superintendent did not in any way detract from the value of the information which the latter was looking to secure. The writer believes that much good resulted following this practice. The master mechanics appreciated that they were being given at least an "even break," and that there was no desire on the part of the inspector to parade faults before the management that could be controlled on the division.

After thus expurgating details the points to be enumerated in the inspection resolved first into the condition of the tires, and particularly in reference to sharp flanges; second, the amount of end play or lateral motion present, whether in engine truck or driving boxes; third, the consideration of broken parts, whether frames, wheel centers, cylinders, or the less important members; and fourth, an analysis of neglect on the part of the local supervision to maintain the engine, tempered, of course, by an inquiry into their existing facilities to do so.

The reports on each engine, therefore, assumed the form of notes, ranging in length from ten to three hundred or more words, and the individual examinations were made with the above synopsis ever present in the mind of the inspector as a working basis.

The second problem which must be solved before any real work could be done, viz., the proper definition of the condition of the engine as indicated by the inspection above outlined, embodied at least the postulate that each one must be termed "good" or "poor." It was thought best, however, to oppose an intermediary between these extreme designations; hence all were defined as "good," "fair" or "poor." In advising the general mechanical superintendents of this decision before forwarding any reports the following conditions were adopted as governing the application of the three terms.

Good engines to be those which would apparently run for at least six months, as indicated by the inspection, without recourse to other than running or roundhouse repairs.

Fair engines to be those which the inspection discloses will not run six months without receiving heavier repairs than the roundhouse can give.

Poor engines to be those no longer fit for service, through generally worn parts, or the presence of manifestly improper conditions, such as broken frames, in particular; and, with more conservatism, cracked wheel centers, etc.

It is agreed that this plan for defining power is open to criticism, but as well this as any other in view of the generally admitted fact that there is no standard scheme for arriving at such conclusions. The separate divisions of a single railroad, which the inspection disclosed in this instance, are at the utmost variance in their interpretation of forms intended to be self-explanatory in reporting conditions. On the majority of roads, including the A. B. C. Railroad, there is a standard form to be forwarded by the master mechanic on the first of the month, one for each locomotive under his jurisdiction, and presumably adequate to define the condition of the engine for ready appreciation. These forms, as a rule, embody considerable detail in enumerating the parts most susceptible to wear. Opposite the various items an explanatory symbol is placed by the person making them out; for instance, "X" implies perfection; the figure "1," very good; "2," good; "3," fair; "4," poor, and "5," very poor.

If one man so valued the different items for every engine on the railroad, these forms would be of comparative value, but through the conditions under which they are generally compiled, they are practically worthless from that standpoint, because twelve inspectors, representing as many divisions, have their individual ideas regarding the values of X, 1, 2, 3, 4, and 5. The writer recalls a set of side rods marked "2" on division C, while on the K division a similarly designed set in exactly the same condition were defined as "5." There are hundreds of parallel illustrations, but the point intended to be conveyed is no doubt appreciated without further elaboration.

These reports are made up, as a rule, by the local engine inspector or roundhouse foreman, and through the heavy pressure of work devolving on each of these men, their preparation is generally neglected until the day on which they are due in the master mechanic's office to be copied and forwarded. In consequence they will, in all probability, use the last month's reports as a basis, raising the symbols here and there to indicate additional wear which thirty days' service would seem to imply. If rods and motion work have been rated "1" they will likely be raised to "2"; and if the tire wear has been "1-32," it will be increased to "2-32," with no actual examination in either case, and notwithstanding that no appreciable wear may have ensued in any of the parts under consideration. It might be indeed that actual renewals were made since the last report which served to return the part affected to "X," but these are frequently forgotten in the rush to get the new reports out on time. It must be plainly said that such forms as a whole are simply a hodge podge of incongruities. The writer, based on his experience elsewhere, considered them as absolutely valueless in the direction of lightening his labors while engaged in the general inspection of the A. B. C. Railroad, and did not ask permission from a single master mechanic to look at one of them during his entire long trip over the line, until after the report of his own conclusions had been forwarded.

The adoption of the definitions "good," "fair" and "poor," no matter what shortcomings they may evince, were adequate in this connection, because their application was made by the same person to all of the locomotives examined. The same presumed requirements to meet ideal conditions were held steadily in mind from the first locomotive examined to the last, and in view of this uniform treatment, the conclusions were impartial and served to portray what was desired.

The following examples of the individual engine reports submitted by the inspector are literal reproductions from his files, the only change being the disguise of the engine number and class. These notes were, of course, not forwarded singly, but were held until sufficient had been accumulated to make up a letter, generally ten or fifteen. The average speed of the inspection was twelve locomotives per day, but other assignments from time to time prolonged the entire inspection to over ten months. In every instance the master mechanic interested received a carbon copy of the letter above mentioned. This was merely for his information, as the inspector had no authority to order work done or to correct abuses.

Engine 4361, class Z-12, 2-8-0. Tires 2⅝", wear 9/32". Comment: 1" end play in engine truck. Right cylinder banded at back end, but when inspected band was banging loose. 1" end play in driving wheels, and metal is entirely off face of left main driving box. Bottom rail of left main frame broken ahead of main pedestal, and left main pedestal binder has been pieced to hold frame ahead of fracture: appears to be adequately repaired for the time being. Frame key ahead of right cylinder is working and has a dutchman. Side rod brasses generally are unfit for further service in present condition. Right No. 1 brass is broken; bolts are loose, and strap is working on the rod. Right No. 2 brass is loose in rod, and all knuckle pins pound heavily. Valve gear in wretched shape; shows over 1" on right valve stem, and ¾" on left stem. The transmission bars are much worn and nuts are loose on bolts. Both crossheads pound bad in guides. Drawbar wants shortening. Some of the pedestal binders have temporary bolts. If it is desired to continue this engine in service it should at least be thoroughly tightened up underneath, otherwise it will speedily break down. General conditions "Poor."

Engine 6852, class P-21, 4-6-2 (new engine). Tires 3", wear 2/32". Comment: Engine gathering end play very rapidly in the trailing wheels. In this instance it appears to result from excessive wear due entirely to inadequate lubrication. I have noticed generally in engines of this class that this part is dry and does not seem to receive attention. There is no provision for feeding oil to the face of the liner, and any neglect on the part of the engineer is liable to result in cutting or possibly twisting the liner off. General condition "Good."

Engine 2831, class Z-16, 2-8-0. Tires 3", wear 9/32". In general "Poor" condition (awaiting shop, and will not be used until repairs are made).

Engine 4051, class Z-17, 2-8-0. Tires 2⅛", wear 7/32". Comment: Left crosshead has ¾" lateral play in guides; bottom gib is working, and has dutchman. This requires repairs at once; it is in poor shape. Left engine truck wheel is wearing a sharp flange. Right cylinder banded. ½" to ¾" end play in driving wheels. One of the two bottom bolts is broken in back hanger of right No. 1 driving spring, and spring has "U" clamp over it encircling frame. This clamp is over spring about six inches back of band, with its other end in the fillet of the main frame where the pedestal leg joins the frame back. This wretched arrangement transmits all shock to the main frame at its recognized weakest point. It will break the frame in time. General condition "Fair."

Engine 5051, class Z-17, 2-8-0. Tires 3", no wear. In general "Good" condition. No special comment.

Engine 2261, class X-9, 4-4-2. Tires 2⅝", wear 5/32". Comment: Right main driving tire has sharp flange, and will take gauge. Left front driving tire has flange about down to gauge and will bear close watching. Guides, both sides, require closing; the inside bars are the worst. It is a fact for all engines of the A. B. C. railroad, having four bar guides that the inside bars are always in poor shape, at least embodying more crosshead pound than the outside bars. The reason is no more or less than that the inside bars are hard to get at by the persons actually engaged in closing guides; hence they are neglected. It is very bad for crossheads, with guides of this type, to allow any discrepancy between the wear of the outside and inside bars, as with any inequality in this regard it subjects the cross head to a milling motion between the tighter bars. This is supposed to explain why crossheads of this pattern are generally always rounded on the wearing surface for the outside bars. The driving box wedges are pretty well up on the engine and will require lining soon. Driving box shoes are shouldered above the boxes, and this suggests the fact that the best practise is not followed in our shops of milling the face of the shoe and wedge for about three inches down from the top, to a depth of say 1/16", although it is followed in spots. There is 1½" lateral motion in the trailing wheels by actual measurement. This condition merely converts the engine into a track-spreading device when at speed. Eccentric straps are much worn, and have heavy pound on cams. Links and transmission bars worn generally. Left main side rod bushing very loose in rod. Right main frame broken back of No. 1 pedestal, top rail. This has not been patched, and all stresses supposed to be borne by this part when in normal condition are now transmitted to other parts not designed to sustain them. General condition "Poor."

Engine 2999, class B-11, 0-6-0. Tires 2", wear 11/32". Comment: The driving tires of this engine are worn so unevenly that it becomes quite difficult to secure a measurement of approximate correctness, even with the most improved self-adjusting measuring devices. However, the 11/32" wear above mentioned applies best to the tire on right No. 1 driver. This tire is 2" thick, and is, over the grooving, as these measurements are always returned. It embodies a flange in such a condition that attention must be invited to it. It is worn sharp below the standard 1" limit gauge, and to what we commonly term a "knife edge" as descriptive of a very sharp flange. Furthermore, this flange is 1¼" deep, measuring vertically from what remains of the throat of the flange. This tire is not in a fit condition for any service. The depth of grooving in the other tires is, right No. 2, 9/32"; right No. 3, 8/32"; left No. 1, 8/32"; left No. 2, 8/32", and left No. 3, 9/32". Back driving wheels have 1⅛" end play, and main wheels 1" end play. Shoes and wedges are much worn and are heavily shouldered immediately above the driving boxes. Right main driving box wedge is blocked up on a piece of wood. Flange is broken entirely off left main wedge, and left No. 1 wedge is tight against top of frame and blocked, with nearly ⅛" pound in that box between shoe and wedge faces. Both crossheads are pounding severely in guides. Driving box crown brasses worn very thin. Side rod brasses pound bad. Rockers are loose in boxes and valve motion is worn generally. Since gathering the above notes I am advised by the road foreman of engines that this engine is intended for shop in a day or so, hence this description is not continued in detail. General condition "Poor."

Each division was, of course, separately inspected and finally reported on before passing to the next, and after notes similar to the above had been returned accounting for each engine on that division's assignment, these were compiled by the inspector into a final report of the division. It merely remained to count the totals of engines defined as "Good," "Fair" and "Poor," in the reports already submitted from that territory, to form the proper recapitulation explanatory of the local situation. In this recapitulation was included the number of engines in the back shop belonging to that division. The sum of the "Good" and "Fair" engines, that is, the serviceable power, established the percentage of efficiency for each division at the time of the inspection. These final reports also included some discussion of the predominating detrimental conditions, and also a mention of the favorable features which had been noted.

Each final report was prefaced with a recapitulation as above outlined, and of which the following quotation from the "C" division may serve as an illustration:

Engines inspected, 130.		
Engines in "Good" condition,	63, or	48%
Engines in "Fair" condition,	40, or	31%
Engines in "Poor" condition,	17, or	13%
Engines in shop,	10, or	8%
Efficient engines,	103, or	79%

An analysis of the above quoted seven reproductions of the individual engine reports might infer that the description of the various parts was characterized by undue severity, particularly in connection with engines 4361, 4051, 2361 and 2999, but this was not so intended by the inspector. Conditions were so flagrant in these four instances that pardonable enthusiasm in the general cause for the moment misled the inspector from the conventional path of delineation without personal comment. Happily, however, all such of the many occasions wherein this became manifest were viewed with tolerance, not only by the general mechanical superintendent, but by the division master mechanics as well. Indeed, it must be said that the attitude of the latter toward the inspection was most praiseworthy throughout, and to a man they appeared grateful that these things were so brought to their attention. On several divisions these reports served as an awakening to conditions which they never believed could exist; hence the inestimable value of the moral effect pertaining to the inspection, if nothing else.

The true value, however, from a mechanical standpoint of the 1526 individual reports returned, covering each engine on the A. B. C. system, was in the analysis of the most recurrent items which these notes exhibited in the aggregate. For instance, through them all must run a preponderance of something. If in the final summary five hundred times the mention was made of excessive lateral motion in driving boxes, then there must be a crying need for a remedy in this quarter; if three hundred cases were present of unduly pounding crossheads, something is radically wrong, and if the final count should exhibit one hundred broken frames in service, the mention affords food for reflection on whether the design is fundamentally weak or whether or not wrought iron is adequate for the purpose of frame construction.

If on the A. B. C. Railroad the degree of curvature is about the same for all divisions, and one particular division is indicated by the reports as having a majority of sharp or cut flanges, logically something must be amiss with the tire setting on that particular division; or, if it should be noted that on the "K" division the guide cup tops are all on, whereas on the majority of the other divisions they were found all off, then the other divisions are not adequately maintaining their oil cup tops, and thus it goes to the end of the chapter.

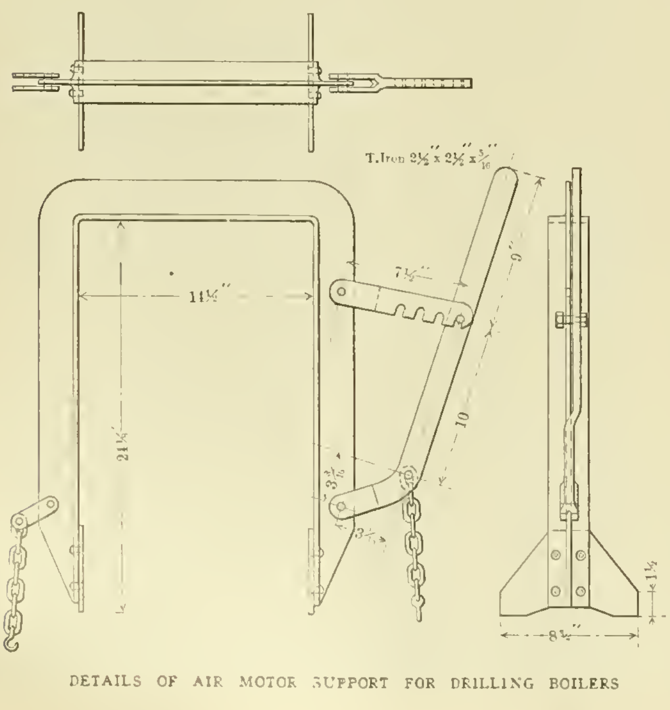
The inspection effectually developed the fact that notwithstanding the uniformity presumed to exist in the appreciation of conditions detrimental to locomotive efficiency, there is, nevertheless, a singular divergence of opinion among master mechanics in regard to the valuation to be placed on these several detrimental features. On one division it was found that the driving box wedges were maintained in a manner to absolve them from the slightest criticism, while at the same time the rod brasses and knuckle pins on these identical engines were in utter disrepute. On the very next division, however, the condition of the rods was irreproachable, but the wedges were jammed against the top of the frame, as high as they would go, with the driving boxes pounding terrifically in the jaws. One master mechanic laboriously patched everything that broke, whether frames or crossheads, but another advanced that the part never would have failed if it had not embodied a latent defect, and insisted on its renewal. It was this divergence of opinion on every hand which gradually inclined the writer to the opinion that the master mechanic is a much more subtle factor in the scheme of locomotive maintenance than is commonly suspected. The consideration of this feature served to endow the inspection with a distinctively human element certainly not anticipated by the inspector when his work was inaugurated.

There was another end in connection with this inspection which has not been alluded to, and this the inspection of the standard practices prevailing in the general shops of the A. B. C. Railroad, but the mention of this properly belongs in the succeeding article, which will treat in some detail on what the inspection actually disclosed in connection with the wear and tear of locomotives while in service, and the differences exhibited in the latter between the various divisions.

FOR THE SHOP SUPERINTENDENT AND FOREMAN.

AIR MOTOR SUPPORT ON BOILERS.

When using an air motor for drilling on boilers it is often practically impossible to securely fasten the ordinary drill post so that it can be used, if in fact it is possible to use it at all, and in the different shops throughout the country many ingenious schemes have been devised for holding the motor when doing this work.



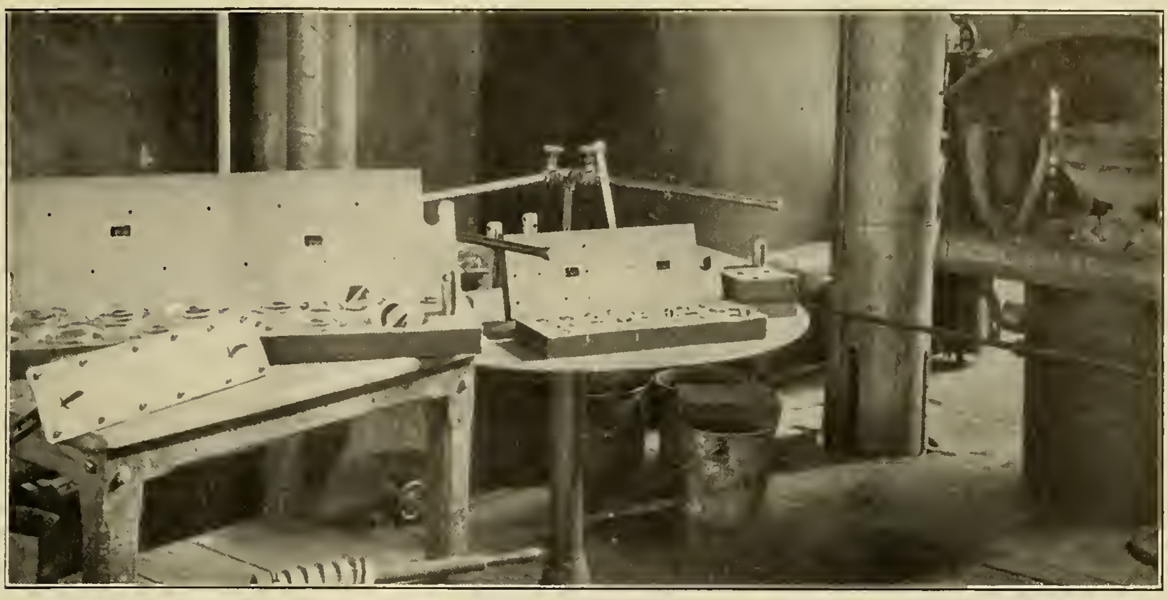
DETAILS OF AIR MOTOR SUPPORT FOR DRILLING BOILERS

One of the handiest of these devices is shown in the illustration and is in use on the Lake Shore & Michigan Southern Railway. It is light, quickly applied and can be securely held in place. It is very easy to move to suit the proper angle at different places and it forms a very secure support.

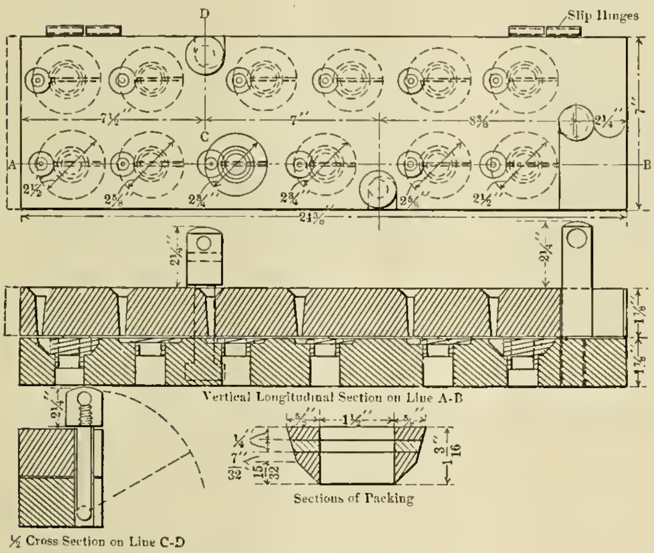
In construction it consists of a 2½ x 5/16 in. T iron bent to a U shape about 24 in. deep, and having at its extremities a plate 8⅜ in. wide, notched out in the center, to give a secure footing on a round surface. On one side of this U a short piece of chain with a hook is secured and on the opposite side is a lever to which a longer section of the chain is fastened at the proper point to give a toggle joint effect and a very strong pull as the lever is drawn into place. A latch for holding the lever when secured is provided and the whole affair can be fastened to any boiler or tank of any diameter and accurately located in a very short time.

MOULD FOR METALLIC PACKING.

Valve stem and piston rod packing which requires only to be bored to be ready for application can be cast in the moulds shown in the accompanying illustrations. These consist of two heavy slabs of cast iron, about 2 inches thick, joined together by hinges, which permit the upper plate to slide over the lower. The lower slab is drilled and finished to the proper shape for the outside of the different sections of the packing and steel rings of the proper size for forming the inner surface and having a projection for making the slit in the side, are inserted in each mould. In the top plate, which is smooth on its lower face, are the gates for pouring.

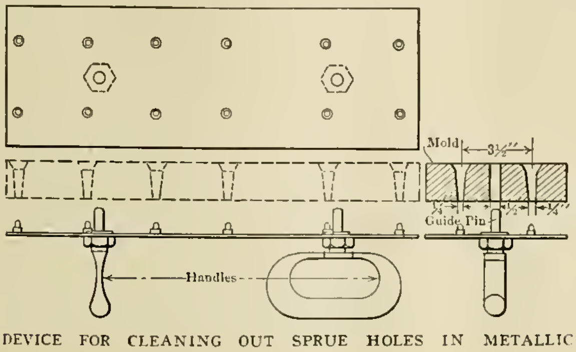


VIEW SHOWING ARRANGEMENT FOR MOULDING METALLIC PACKING, WHICH REQUIRES ONLY BORING. THE CIRCULAR TABLE REVOLVES AND THE PIPES SHOWN ABOVE IT KEEP A STREAM OF AIR PLAYING ON MOLDS. ONE OF THE PLATES FOR CLEANING SPRUE HOLES IS SHOWN ON THE TOP OF THE TABLE AT THE LEFT AND THE STICKS ON WHICH THE PACKING IS STORED AND TRANSPORTED ARE ILLUSTRATED BY THE EXAMPLE LYING UNDERNEATH THE TABLE.



DETAIL OF MOULDS FOR METALLIC PACKING.

These moulds are poured on a revolving table in sets of four and after each is filled the table is revolved so that it brings it underneath a horizontal pipe, which keeps a stream of air playing over the moulds continuously. They are kept in this circulation of air until the four moulds have been filled; then a bar is inserted through the post which is seen projecting up on the right hand side of each mould and it is given a half turn, which, because of its eccentric setting, slides the upper plate on the lower and cuts off the metal at the gates, so that the surface of the packing is perfectly smooth. The same bar is used for raising the top and the packing is removed and put upon specially shaped carriers, one of which is shown in the illustration.



DEVICE FOR CLEANING OUT SPRUE HOLES IN METALLIC PACKING MOULDS.

The metal remaining in the sprue holes is ejected by means of a special set of punches, inserted from underneath. The construction of these is also shown in the illustration.

Packing coming from these moulds is as smooth as could be desired on the outside and is periodically fitted to a master gauge to see that it is maintaining its proper shape. The three pieces forming one set, are assembled and bored to suit the size of the rod they are to be used upon, after which they are ready for application.

This photograph was taken in the Readville shops of the New York, New Haven & Hartford Railroad.

LUBRICATION AND LUBRICANTS.

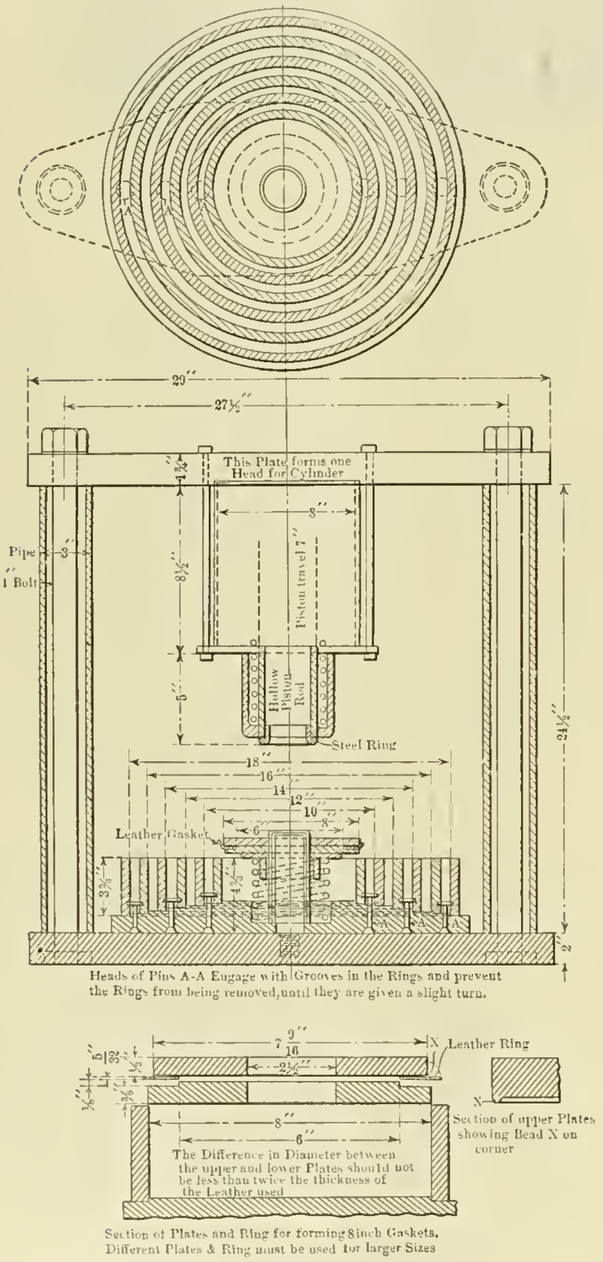
Prof. Charles F. Mabery, professor of chemistry at the Case School of Applied Science, presented a paper on the above subject at the January meeting of the American Society of Mechanical Engineers in New York City. His conclusions, based on a series of tests at Case School, are as follows:

"The results with reference to the uses of graphite as a solid lubricant indicate that in the deflocculated form it can be applied with advantage in all kinds of mechanical work. One of its most characteristic effects is that of a surface evener by forming a veneer equalizing the metallic depressions and projections on the surfaces of journal and bearing, and, endowed with a certain freedom of motion under pressure, it affords the most perfect lubrication. In automobile lubrication the great efficiency of graphite in increasing engine power, in controlling temperatures, and wear and tear of bearings, has been brought out in a series of tests conducted by the Automobile Club of America. In connection with the reduction in friction of lubricating oils by graphite the extremely small proportion necessary is worthy of note; the proportion used in this work is equivalent to one cubic inch of graphite in three gallons of oil. The curve of temperature for Aquadag, showing only slight increase above that of the surrounding atmosphere, demonstrates an important economic quality of controlling temperatures in factory lubrication, and thereby avoiding the danger of highly heated bearings, which are frequently the cause of fires.

"In the observations described in this paper, and, in fact, in all the work that has been done in this field, there is not a more impressive example of the efficiency of graphite in lubrication than that presented in the curves of friction and temperature of water and graphite, for with water, serving merely as a vehicle and completely devoid of lubricating quality, the graphite is permitted to perform its work without aid and with no limiting conditions."

FORMING BRAKE CYLINDER PACKING.

The difficulty of inserting a new leather packing in a brake cylinder is well known and for the purpose of facilitating this work at the Readville shops a special press with suitable forms for crimping the edge of packing for different sized



DETAILS OF PNEUMATIC PRESS FOR FORMING BRAKE CYLINDER PACKING.

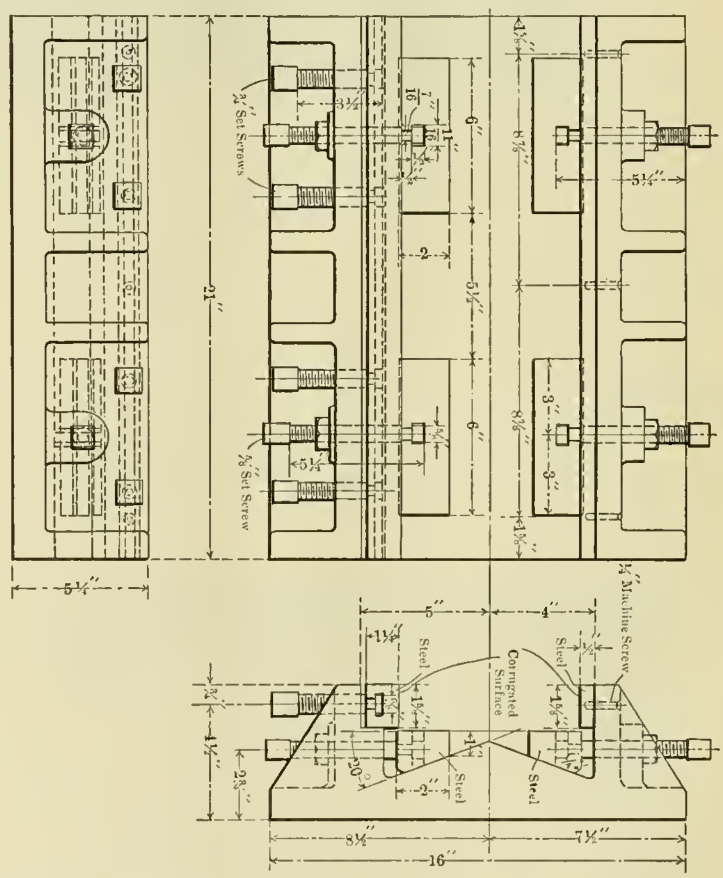
cylinders has been designed. This, as will be seen by reference to the illustration, consists simply of an ordinary 8-inch brake cylinder secured to a suitable frame and a series of rings and plates that can be fitted to the base below it.

In operation the proper sized ring is set into place and a light turn locks it. A plate that fits closely inside of it is placed over the center pin above the spring, the leather packing is then laid on this, and above it another plate, with specially shaped beads on the edges and a diameter equal to the difference between the lower plate and a double thickness of the leather, is placed. Air then being admitted to the cylinder, the plates are forced down into the ring and the leather is crimped smoothly and so evenly that it can be easily applied to the cylinder. Upon release the spring around the center pin forces the plates and packing out of the ring.

CHUCK FOR PLANING SHOES AND WEDGES.

For various reasons it often happens that the face and back edges of shoes or wedges are not in line, which necessitates accurate setting for the final planing of the face after it has been laid off on the locomotive.

At the West Albany shops of the New York Central a chuck has been designed by which this setting on the planer or shaper



DETAILS OF JIG FOR PLANING SHOES AND WEDGES, WEST ALBANY SHOPS.

can be quickly and accurately done. It consists of a bed plate with screw clamps for holding the shoe or wedge in place and four wedge shaped blocks, one near either corner on which they rest. These blocks slide on inclined faces, and are raised and lowered any desired amount by being forced inward and outward through the medium of screws projecting out through the side of the lower casting. It is easily seen that irregularity of the lower face can be quickly adjusted in this manner. Having obtained the proper surface, the piece is securely clamped by tightening up on the four set screws on one side.

"The Weathering of Coal," by S. W. Parr and W. F. Wheeler, is being issued by the Engineering Experiment Station of the University of Illinois as Bulletin No. 38. This bulletin embodies the results of weathering tests conducted on car-load lots of coal for a period of one year, in the course of which coal from various mines was exposed in covered bins, open bins and under water. The results are presented in the form of charts which show graphically the losses in heating value resulting from each condition of exposure. Copies may be obtained graits.

THE ELECTRIC SYSTEM OF THE GREAT NORTHERN RAILWAY COMPANY AT CASCADE TUNNEL.*

CARY T. HUTCHINSON.

The first three-phase installation on a trunk line railway in the United States was put into operation early in July, 1909, at the Cascade Mountain tunnel on the Great Northern Railway, in the State of Washington, about one hundred miles east of Seattle.

In general the plant comprises a hydroelectric generating station, operating under a head of 180 ft., having a capacity of approximately 5,000 kw. in generators at 6,600 volts and 25 cycles; a transmission system operating at 33,000 volts, delivering energy to a sub-station where it is transformed to 6,000 volts, at which pressure it is supplied to the overhead conductors and to the locomotive by way of an overhead trolley; on the locomotive the pressure is reduced by three-phase transformers to 500 volts for the supply of the four three-phase motors with which each locomotive is equipped.

The Great Northern Railway crosses the Cascade Mountains through a tunnel 13,873 ft. long; this tunnel is on a tangent and has a uniform gradient of 1.7 per cent., rising to the tunnel from Leavenworth, on the east; the ruling grade is 2.2 per cent., and 21 per cent. of the total distance of 32.4 miles from Leavenworth to the tunnel is on the ruling grade. From Skykomish on the west to the summit the ruling grade is 2.2 per cent. and 44 per cent. of the distance of 24.8 miles is on the ruling grade.

The operation of the tunnel with steam locomotives was at all times difficult and frequently very dangerous on account of the heat and smoke from the locomotives. Crows Nest coal, which is exceptionally free from sulphur and gas-forming materials, was used for the tunnel service. It was the custom to clean the fires of each locomotive and to put on just sufficient coal to carry it through the tunnel. In the tunnel the rails became very wet from condensed steam, and were frequently covered with a layer of coal soot, and ground sand, making them very slippery. The temperature in the locomotive cab was almost unbearable, rising at times as high as 200 deg. Fahr. Under ordinary circumstances it required from twenty minutes to an hour for the tunnel to clear itself of gases, but on days when the wind was changeable, the passage of the gases from the tunnel would be stopped by the change in the direction of the wind, and they would pocket. Under such circumstances, work in the tunnel was very dangerous. There are refuge chambers containing telephones every quarter of a mile, but it was a difficult matter to keep these instruments in order, on account of the gases, smoke, and moisture.

The tunnel is lined with concrete throughout its length, and is in good condition. The roof is practically dry. The entire tunnel drips more or less from condensed steam just after the passage of a train, but is comparatively dry at other times. The temperature changes at the top of the tunnel are very rapid, varying from atmospheric temperature to several hundred degrees Fahr. from the heat of the locomotive exhaust. For these reasons this tunnel is the limiting feature to the capacity of the Great Northern Railway for hauling freight across the mountains.

Mallet compound engines are used on this division, one at the head of the train, and one pushing. The mountain section as a whole also fixes a limit to the capacity of the road, on account of the slow speed necessitated by heavy traffic; it is impossible for steam locomotives to haul heavy trains on the mountain at a greater speed than seven or eight miles per hour.

The plant described is designed for use over the entire mountain division, by extending the system of conductors and building additional stations; it was not designed for the operation of the tunnel alone, although even if the problem had been the handling of the traffic through this tunnel and its approaches only, the three-phase system would in all probability have been selected, on account of its greater simplicity and less cost.

* Abstract from the Proceedings of the American Institute of Electrical Engineers, Volume XXVIII, Number 11, November, 1909.

The original problem was to provide equipment to handle a train having a total weight of 2,000 tons, excluding the electric locomotives, over the mountain division from Leavenworth to Skykomish, a distance of 57 miles. The system was to be first tried out at the Cascade Tunnel.

The tractive effort required to accelerate a train having a total weight of 2,500 tons on a 2.2 per cent. grade, using 6 lb. to the ton for train resistance and 10 lb. to the ton for acceleration, making a total of 60 lb. to the ton, is 150,000 lb.; this would require four locomotives of a tractive effort of 37,500 lb. each. The railway company's engineers limited the weight on a driving axle to 50,000 lb.; therefore four driving axles per locomotive are needed, giving a coefficient of adhesion of about 19 per cent. This is a measure of the maximum power required. The locomotive was, therefore, designed to give a continuous tractive effort of approximately 25,000 lb., and it was expected that four would be used with a train of maximum weight. But the locomotive as built greatly exceeds this specification.

The General Design of Locomotive

The principal data of locomotive are as follows: total weight 230,000 lb. all on drivers; two trucks connected by a coupling, each truck having two driving axles; a three-phase motor connected by twin gears to each axle; gear ratio, 4.26; diameter of driving wheels 60 in.; synchronous speed of motor 375 rev. per min., giving a speed of 15.7 miles per hour at no load, dropping to 15 miles per hour for a load corresponding to the one-hour rating. The motors are wound for 500 volts and are completely enclosed and air-cooled; clearance between stator and rotor, ⅛ in.; trolley pressure, 6,000 volts; each locomotive has two three-phase transformers reducing the pressure from 6,000 to 500 volts, arranged with taps so that 625 volts may be used on the motor.

The distribution of the total weight of the locomotive is as follows:

2 Trucks	81,599 lb.
1 Cab	30,000 "
4 Motors	48,800 "
8 Gears and gear cases	11,000 "
2 Transformers	20,800 "
2 Air compressors	5,800 "
1 Blower	1,300 "
40 Rheostats	10,200 "
56 Contactors	3,200 "
Miscellaneous	17,400 "
Total	230,000 lb.
That is,	
Total weight per axle	57,500 "
Dead weight per axle	18,500 "

The locomotive will give 37,400 lb. tractive effort in continuous duty, or 47,600 lb. tractive effort for one hour.

Calculations from the profile of this section give:

Westbound, Leavenworth-Cascade	
Average up-grade	1.37 per cent.
Distance	32.4 miles
Work per ton at the wheel rim	2.15 kw.-hr.
Average power per ton at the wheel at 15 miles per hr.	1.00 kw.
Eastbound, Skyomish-Cascade	
Average up-grade	1.88 per cent.
Distance	24.8 miles
Work per ton at wheel rim	2.16 kw.-hr.
Average power for round trip per ton at wheel rim at 15 miles per hour	1.31 kw.
Average power per ton at wheel at 15 miles per hour for entire division	1.12 kw.
Maximum power per ton accelerating on 2.2 per cent. grade	1.8 kw.

These figures assume the train to be moving continuously and are based on 6 lb. per ton train resistance on the level, as are all calculations herein unless otherwise stated.

The average power of the locomotive when pulling will then be 1.12 kw. per ton, and therefore each motor can carry 250 tons in continuous service on this mountain division, assuming there are no stops and no opportunity for cooling; or each locomotive could haul $(4 \times 250 - 115) = 885$ tons trailing load, if the power requirements were continuous; as there are necessarily stops, the rating as determined by heating is somewhat greater than this.

The locomotive has been tested to a maximum tractive effort of nearly 80,000 lb., corresponding to a coefficient of adhesion of nearly 35 per cent.; with 60,000 lb., or 26 per cent., each locomotive can accelerate the train of 885 tons trailing on a 2.2 per cent. grade, using 60 lb. per ton as the total tractive effort; or, in other words, the train that a locomotive can haul, as determined by the average duty and safe heating limits, is just about equal to the train that it can accelerate on the maximum grade; that is, the average capacity of the locomotive and its maximum capacity are in the same proportion as the average duty and maximum duty. The design is well balanced.

Making some alowance for these figures for the sake of conservatism, the rating of the locomotive on this division can be put at 750 tons trailing load.

Mechanical Design of Locomotive

The locomotive is of the articulated or hinged type, having four driving wheels on each half of the running gear and is without guiding wheels. The running gear is not two independent trucks coupled together, but is more nearly comparable to the Mallet type of steam locomotive, in that the hinged sections are so rigidly connected that they tend to support each other vertically and guide each other in taking the curves, although the hinges are designed to offer minimum resistance to lateral flexure. There are no springs to prevent this flexure, and the wheel base is free to accommodate itself to any curvature; the effect of this guiding action is to minimize the flange wear, as in the Mallet locomotive.

Operation of the System

The electric service was started on July 10, although one or two trains had been handled previously. From that time to August 11, practically the entire eastbound service of the company has been handled by electric locomotives. During this period of 33 days there have been 212 train movements, of which 82 were freight, 98 passenger, and 32 special. In each case the steam locomotive was hauled through with the train. The tonnage handled was as follows:

Freight tonnage	171,000 tons.
Passenger "	88,500 "
Special "	15,500 "
Total	275,000 tons.

This is an average of 8,350 tons per day, all eastbound.

The average freight train weight has been as follows:

Cars	1,480 tons.
One Mallet locomotive	250 "
Three electric locomotives	345 "
Total train weight	2,075 tons.

The maximum weight of cars was 1,600 tons; the minimum 1,200 tons.

The representative passenger train handled is made up as follows:

Coaches	426 tons.
One steam locomotive	250 "
Two electric locomotives	230 "
Total train weight	906 tons.

The maximum was about 125 tons greater.

Frictional resistance of steam locomotives.—The power required to haul these trains seemed greater than it should be; investigation showed that the difference was accounted for by the unexpectedly high frictional resistance of the steam locomotives, as a trailing load; tests were made on several engines with the following results:

TABLE III.

1	2		3	4	5	6
Test No.	Engine classification		Total weight with tender Tons	Weight on drivers Tons	Total resistance on 1·7 per cent grade lb.	Equivalent weight of freight cars Tons
1	Mallet No. 1904	2-6-6-2	250	158	19,340	482
2	" No. 1911	2-6-6-2	250	158	17,500	432
3	" No. 1905	2-6-6-2	250	158	24,200	602
4	Consolidation	2-8-0	159	90	10,080	255
5	Pacific	4-6-0	188	70	10,270	257

The tests were made by towing an engine through the tunnel behind an electric; the electric was fitted up with test instruments and the total tractive effort was thereby obtained. An allowance of 6 lb. per ton was made for the resistance of the electric and the difference is the draw-bar pull in column 5. Column 6 is the equivalent load in cars, taking car resistance as 6 lb. per ton. Each test given is the average from six to twelve separate readings. The average for the three Mallets is more than 20,000 lb.

If the grade resistance be deducted from the total pull, and the difference lumped as "lb. per ton" for the locomotive and tender, there results:

TABLE IV.

1	2	3
Engine classification	Frictional resistance of locomotive	lb. per ton
Mallet No. 1904	10,840 lb.	43.0
Mallet No. 1911	9,000 "	36.0
Mallet No. 1905	15,700 "	63.0
Consolidation	5,480 "	34.5
Pacific	3,870 "	20.7
Electric	1,500 "	13.0

The average for the three Mallets is 47.0 lb. per ton for the frictional resistance on a straight level track.

The figure for the electric was obtained from tests made by towing it by a motor car on straight level track; this test was made at Schenectady. Included in it is the resistance of gears and bearings of motors.

Using 20,000 lb. as the pull required for a Mallet on the 1.7 per cent. grade, the approximate average from Table III, the total tractive effort for the average freight train, is:

Cars	1,480 tons × 40 = 59,200 lb.
One Mallet	250 tons × 80 = 20,000 "
Three electrics	345 tons × 40 = 13,800 "
Total tractive effort	93,000 lb.

This is equal to 31,000 lb. for each electric locomotive.

On account of the very high frictional resistance of the Mallet engine as a towing load, this representative train is equivalent to 1,980 tons, excluding the three electric locomotives, or a total of 2,325 tons, on the 1.7 per cent. grade. This is on the assumption that the draw-bar pull required for the Mallet is replaced by freight cars at 6 lb. to the ton; this represents the average freight train handled.

The tractive effort for the passenger trains varies from 40,000 to 50,000 lb., depending on the number of steam locomotives taken through; two electrics are ordinarily used, although one would answer in nearly all cases.

During this period there have been no delays due to failure of the electric locomotives, and but two trifling delays due to failures of the electric plant, both chargeable to the transmission line and both caused by accidents beyond the control of the operating force.

On August 11 the electric service was discontinued, owing to failure of both water wheels. Service was resumed on September 9 and has been continued regularly since. The plant was taken over by the operating department of the railroad late in September.

The westbound service was not at first handled by the electrics regularly, as there is nothing in particular gained by breaking the trains electrically on this short stretch, but now westbound passenger trains are so handled, for the benefit of the passengers.

Regenerating.—A number of tests have been made to determine the power returned when regenerating; the following is typical:

TABLE V.

TRAIN: MALLET ENGINE, 1,550 TONS CAR WEIGHT, TWO ELECTRICS ON 1.7 PER CENT. GRADE.

Force due to grade	Frictional Resistance	Remainder for acceleration
Mallet 8,500 lb.	11,500 lb.	− 3,000 lb.
1550 tons in cars 52,500 "	9,300 "	+43,200 "
Three electrics 11,700 "	2,070 "	9,630 "
Total for acceleration		49,830 "

This is equivalent to 1,495 kw. delivered to the gears of the motors at 15 miles per hour.

The efficiency of the locomotive is approximately 80 per cent. —hence the power returned to the line, should be 1,200 kw.

The test of this train gave 950 kw.; this difference is due to the standard practice, not yet abandoned, of keeping a certain number of car pressure retainers set on down grade. The Mallet, instead of adding to the delivered power, is an additional load that has to be carried by the train.

A similar test on a ten-car passenger train weighing 950 tons gave:

Delivered power, calculated	590 kw.
" " measured	597 "

In this case there was no added resistance of pressure retainers. These tests merely confirm the calculations, as they should. On a 1.7 per cent. grade, then, one ton, descending at 15 miles per hr., will deliver 0.67 kw. to the system; on a 2.2 per cent. grade it will deliver 0.91 kw.

Efficiency.—The losses in the system when delivering 4,000 kw. to the locomotive, at the west end of the Wellington yard, are:

Place.	Power. Kilowatts.	Per cent.
Power house low tension bus-bars	4,740	100
Sub-station " " "	4,250	89.8
Trolley wheel of the locomotive	4,000	84.5
Driving axles " " "	3,320	70

The average efficiency is somewhat higher than 70 per cent.

Handling of Trains

Economy of Mallets.—It is interesting to compare the performance of a Mallet compound locomotive under the same operating conditions as this system. The data for this are given by Mr. Emerson, superintendent of motive power of the Great Northern Railway Company, in a discussion before the American Society of Mechanical Engineers on locomotives of this type; as an excellent performance he gives these data:

Recent performance shows that on a round trip over this division the L-1 engines handled 1,600 tons with a total of 43 5/6 tons of coal, or equivalent to 25.13 lb. of coal per 100 ton-mile.

The division referred to is from Leavenworth to Everett, 108.7 miles. The work done per ton for a round trip over this run is readily calculated; from the profile I find,

Total rise, westbound	2,212 ft.
" " eastbound	3,440 "
	5,652 ft.

and $5,562 \times 2,000/2.65 \times 10^6 = 4.26$ kw.-hr., at the rail; this is the work done per ton in lifting the train; the work done against train resistance, assuming resistance to be 6 lb. per ton, for 108.7 miles, is 1.3 kw.-hr.; the total work done in round trip per ton 5.56 kw.-hr. There should be a negligible addition to this for starting the train.

The average train weight is:

Cars	1,600 tons.
One engine, 109 miles	
Second " 58 "	
Equivalent engine weight	380 "
Total	1,980 tons.

The coal used was 43 5/6 tons, equal to 87,660 lb.

Coal per ton	44.3 lb.
Coal per kilowatt-hour	8.0 "

A modern steam station can deliver one kilowatt-hour for 3 lb. of coal, at the bus-bar, which, with an efficiency of 70 per cent. to the rail, gives a consumption of 4.28 lb. per kilowatt-hour at the rail; in other words, the Mallet compound requires nearly twice as much coal per kilowatt-hour at the rail as would be used in a modern steam station in the place of the hydroelectric station at Leavenworth.

Advantages of 3-Phase System

This plant has demonstrated, in my opinion, that the three-phase induction motor has certain very marked advantages over any other form of motor for heavy traction on mountain grades; these advantages may be stated somewhat approximately.

Maximum electrical and mechanical simplicity.—This point is of great importance and was one of the principal reasons for using the three-phase system; the motors will stand any amount of abuse and rough use.

Greater continuous output within a given space than can be obtained from any other form of motor.—This, I believe, is shown by comparison with other electric locomotives; it is due to the fact that the losses can be kept lower in a three-phase motor than in any other type.

Uniform torque.—This is important, particularly at starting. I believe that a three-phase motor will work to a three or four per cent. greater coefficient of adhesion than a single-phase motor at 15 cycles.

The possibility of using 25 cycles.—This is important, as it leads to a less cost and a better performance of power station apparatus; moreover, it is standard and the power supply can readily be used for other purposes, as well as for traction; a commercial supply can be provided.

Constant speed.—This is ordinarily stated as a disadvantage of the three-phase motor; but in my opinion it is a distinct advantage in mountain service, particularly the limitation of the speed on down grades. It has also the advantage on up grades that meeting points can be arranged with greater definiteness. There is a general notion that the impossibility of making up lost time with the three-phase motor will be a decided drawback to its use. This would be true if there were the same liability to lose time with three-phase motors; but when a train can be counted on to make a definite speed, without regard to conditions of tracks or of its load, there is less liability to lose time. Although I am not prepared to state that a three-phase motor is suitable for cases where the profile is very variable, yet it is by no means certain that it would not work out well; the question is merely one of making a given schedule between two points with greatest regularity.

Regeneration on down grades.—This matter has been discussed since the earliest days of electric traction, but, as far as I know, has not been, up to the present, put into practice. Although this result can be attained with other forms of motors, yet it is most perfectly attained by three-phase motors, there being no complications involved. This is of importance in reducing the power-house capacity required for a given service; although, no doubt, the saving in power-house capacity will not be as great as indicated by theory, owing to the various emergencies that must be provided for, nevertheless there will be a material saving. A 2,500-ton train on the average down grade of 1.5 per cent. will deliver about 1,400 kw. to the system. The equivalent power house capacity would cost at least $200,000; hence if only 20 per cent. of this can be utilized the saving will equal the cost of one locomotive.

Excessive short-circuit current is impossible and consequently destructive torque on the gears and driving rigging is eliminated. There will be no necessity for the complication of a friction connection between the armature and driving wheels, as in the design of recent large direct-current electric locomotives.

Impossibility of excessive speeds.—Even when the wheel slips the speed remains constant. Therefore, the maximum stresses put on the motor are less and are more accurately known than with any other form of motor.

Disadvantages of Three-Phase

On the other hand, the principal disadvantages of three-phase motor, for traction use, are commonly stated to be:

The constant speed.—This is rather an advantage for this class of service.

Constant power.—The fact that the motor is a constant-power motor and therefore requires the same power at starting and while accelerating as at full speed. While this is true, it is not a matter of any particular consequence in a service where the stops are very few, and consequently the proportion of total time spent in acceleration is small, and where the additional power required to accelerate the train is a small percentage of the power used by the train at full speed. In this particular case on the 2.2 per cent. grade, when accelerating at the rate of 10 lb. to the ton, the power required during acceleration is only 20 per cent. greater than that required at full speed; this is not a serious matter.

Small mechanical clearance.—In this particular motor the clearance is ⅛ in., which is ample for all practical purposes.

Inequality of load on several motors of a locomotive due to differences in diameter of driving wheels. To meet this an adjustable resistance is included in the rotor of each motor, the motors are then balanced up and no further attention is required as long as the wear on the driving wheels is approximately the same. If, at any time, the load becomes badly unbalanced it is a simple matter to readjust the resistances.

Low power-factor of the system.—This does not seem to be borne out by the practice. The power-factor, as shown by the switchboard instruments in the power house, is 85 per cent. This is a good result and is much higher than a power-factor of a well-known single-phase system that I recently had occasion to visit.

Two overhead wires.—There is no doubt that two wires will cause more trouble than one, and in case of complicated yard structure it might not be practicable to use two overhead wires, but where the problem is that of a single track with an occasional turn-out or crossing there is, practically speaking, no more difficulty in maintaining two wires than one.

In brief, in service of this character, the three-phase motor has marked advantages in capacity, reliability, simplicity, and general trustworthiness, when compared with any other motor.

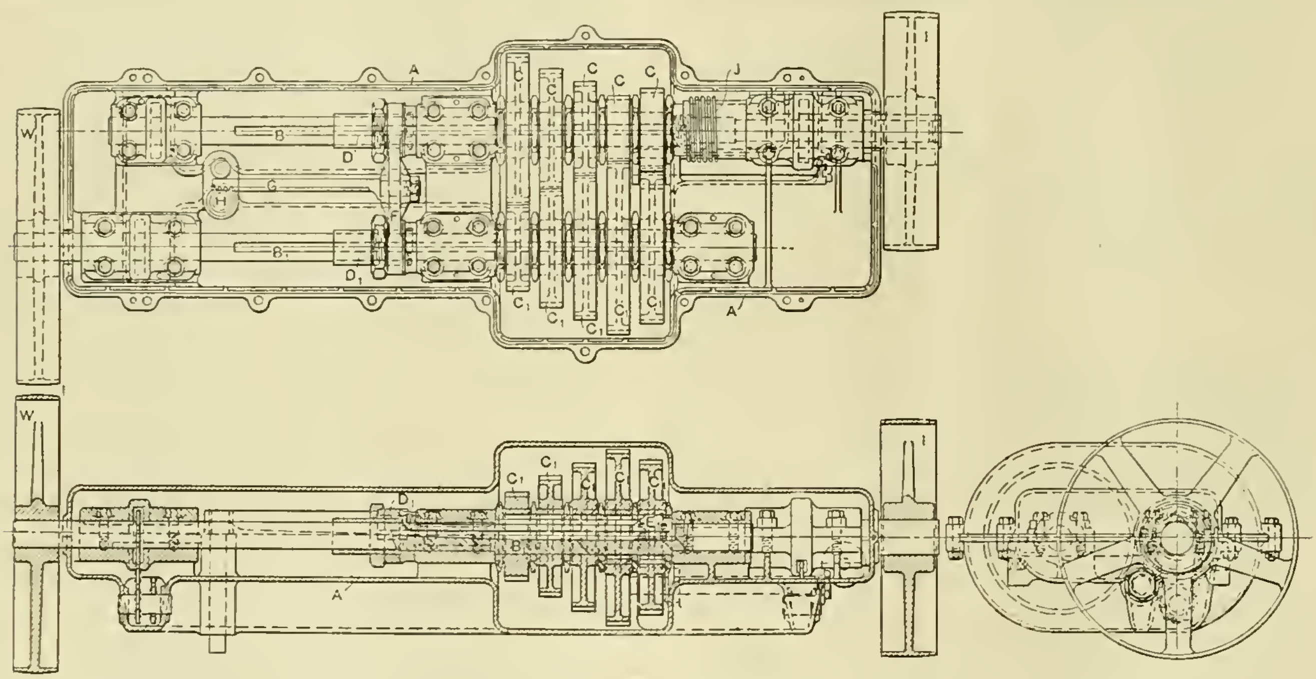
Some Minor Advantages of Electric Traction.

In the many discussions of electric traction which have recently taken place, I do not find several minor advantages sufficiently emphasized. One of these advantages lies in the fact that with electric traction the exact performance and condition of the locomotives and of all elements of the system is accurately known at each moment; on the other hand, with steam locomotives neither the engineer nor the motive power man can have any clear knowledge of the conditions of operation at the moment; he can only ascertain the performance of the locomotive by elaborate tests, which, as a matter of fact, are seldom made. The ratings and performance of steam locomotives are made up largely of "authority" based on a few tests from time to time, and take no cognizance of the actual condition of the locomotives. The importance of this, I think, is clearly brought out by the tests of the steam locomotive cited herein.

With electric locomotives the operation on a heavy grade becomes as simple as on the level; the engineers and train men feel much greater confidence in the electric locomotives and consequently the mountain division ceases to be a terror to them.

Electric traction will permit the use of very long tunnels, which are not now possible on account of difficulty of ventilation. There is no particular reason why tunnels of ten or twelve miles should not be operated as easily as those of one mile.

The great increase possible in the speed of trains with electric traction and the consequent increase in the capacity of a single track will operate to postpone for a long time the necessity for double tracking. This double tracking on a mountain is a very expensive piece of business and this saving alone will, in some cases, more than offset the cost of electrical equipment.



DETAILS OF PARKER TRANSMISSION AS ARRANGED FOR MACHINE TOOLS.

PARKER SPEED CHANGING DEVICE.

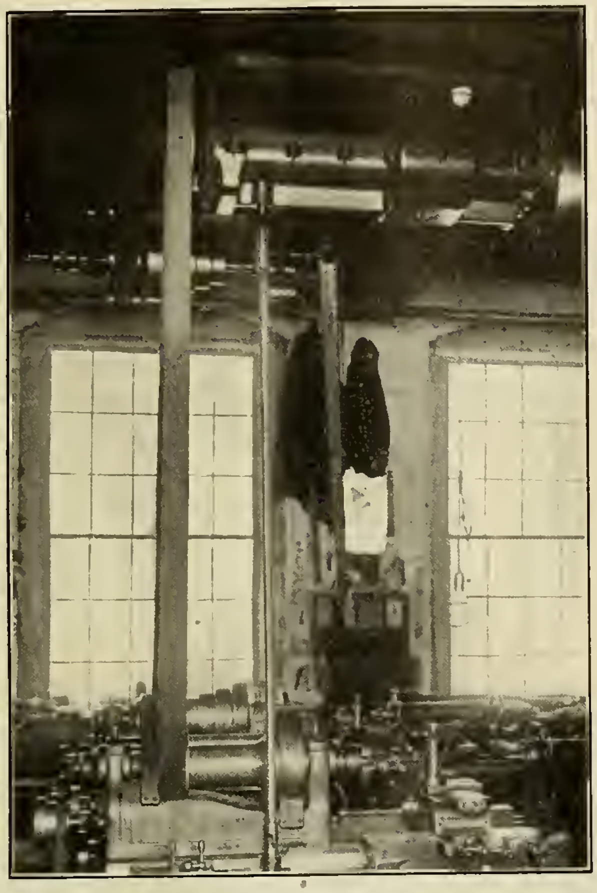
A transmission and speed changing device of the all-geared type, manufactured by the Parker Transmission & Appliance Co., Springfield, Mass., is shown in the accompanying illustrations. This is suited for use on all kinds and sizes of machines that require changes of speed and is particularly applicable to machine tools and automobiles. It gives an absolutely positive drive and can be operated either in a progressive or selective manner. It is of the non-sliding gear arrangement and can be made for any required number of speed changes at any ratio, with any combination of forward and reverse speeds. In the photograph it is shown as applied to a 16 inch Reed engine lathe, in which case the head cone has been removed and a single pulley drive applied. The transmission in this case takes the place of the counter shaft. It can, however, be made as an integral part of the machine, or located upon the floor, if desired.

Two cones of gears in constant mesh and mounted idly on parallel shafts form the principle part of the transmission; a shock absorber, applied at the driving end, is, however, a very important factor. The line drawing shows the arrangement and construction of the whole gear and, referring to it, the five gears C_1, four for forward speeds and one for reverse, are mounted idly on B_1. Meshing with these are five similar gears mounted idly on shaft B. The reversing is obtained by the use of an intermediate gear, as indicated in the end view.

A sliding key E mounted in a slot in the shafts is fitted with springs, so that it will engage in the key-way of any particular set of gears and put them into operation, all others being run idle. Between each of the gears is a collar fastened tightly to the shaft, which acts as a device for releasing the key as it changes from one gear to the other. The upper corners of the key are beveled for this purpose.

These sliding keys are securec to collars D, which slide upon the shafts and are operated simultaneously by yoke F, attached to rack G. The rack is moved by gear H mounted in the end of the vertical rod reaching up from the machine, as is shown in the photograph.

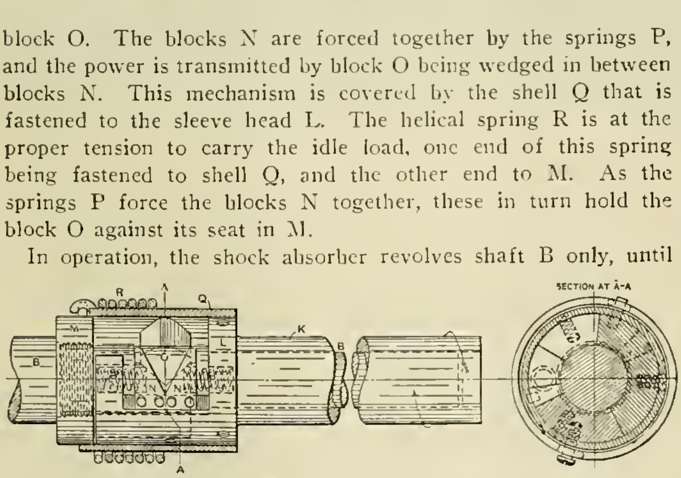
Power is transmitted to the device through pulley I, which delivers it through the shock absorber J to the cones of gears. This shock absorber is shown in detail and prevents any undue wear or breakage of the transmission from a sudden engagement of the gears. Its construction is as follows: The sleeve K is enlarged at L, at which place it is partly cut away. A piece M similar to L is fastened to shaft B. The pieces L and M overlap each other in a clutch-like manner and in the box-like space between them are two wedged-shaped blocks N and a V-shaped



PARKER TRANSMISSION FITTED IN PLACE OF THE COUNTERSHAFT OF AN ENGINE LATHE.

block O. The blocks N are forced together by the springs P, and the power is transmitted by block O being wedged in between blocks N. This mechanism is covered by the shell Q that is fastened to the sleeve head L. The helical spring R is at the proper tension to carry the idle load, one end of this spring being fastened to shell Q, and the other end to M. As the springs P force the blocks N together, these in turn hold the block O against its seat in M.

In operation, the shock absorber revolves shaft B only, until



DETAILS OF SPRING COUPLING IN DRIVING SHAFT OF PARKER TRANSMISSION.

the key in this shaft enters the slot in one of the gears, C, into which it is forced by small springs. Now a single pair of gears is revolved until the slot in the meshing gear C_1 comes opposite key E_1, at which time the key is forced into position in C_1, and now, when both keys are engaged, the working load is transferred to spring R which, not being strong enough to take the whole load, shifts it onto the blocks N and O, the block O forcing the blocks N apart until springs P offer resistance enough to permit the carrying of the load. The mechanism is thus engaged without shock or blow.

The shaft reaching down from the transmission is operated by a handle on the lathe carriage, a pointer and scale being provided to indicate which pair of gears is engaged. It can, however, be readily operated by the ordinary shifting handle, if desired.

Two years' constant service on the lathe shown have not developed any necessity for repairs or adjustment. It has also been applied to a 6-cylinder, 40 h.p., automobile and traveled over 16,000 miles without any necessity for repairs.

TREATED TIES.

The rapid progress of wood preservation in the United States during recent years is disclosed in the rapidly increasing percentages of treated ties in the total annual purchases. In 1908. 23,776,060 ties were reported by the steam and electric roads as having been treated by them or purchased already treated, which was 21.1 per cent. of all of the ties purchased in that year. The corresponding percentages in 1907 and in 1906 were 12.9 and 11.5, respectively. Twelve large railroad companies are now running treating plants of their own, and a number of roads which do not maintain such plants either buy treated ties or have their ties treated after purchase. Altogether, there were in operation in the United States in 1908 about 70 wood preserving plants.

In 1908 the steam roads treated 12,590,643 ties and purchased 10,565,925 treated ties, the total for these roads being 23,156,568 treated ties, or 21.8 per cent. of the total number of ties purchased by them, and 97.4 per cent. of the treated ties reported for that year. The use of treated ties is less general among the electric than among the steam roads. The electric roads treated after purchase 212,356 ties, and purchased in treated form 407,136 ties, making a total of 619,492 treated ties, or 9.6 per cent. of the total number purchased by them.—*From Bulletin No. 109 on Forest Products of the U. S. for 1908, issued by the Dept. of Commerce and Labor.*

Railway Storekeepers' Association.—The seventh annual convention of this association will be held at Planters' Hotel, St. Louis, May 16, 17 and 18, 1910. The following subjects will be discussed: "By What Unit of Measure is the Efficiency of a Storekeeper Properly Determined " "Economy in Mechanical Contrivances for Handling Material," "Economy of the Piece Work System in the Handling of Supplies." Committee reports will also be received on "Recommended Practices" and "Classification of Material." Secretary. J. P. Murphy, Box C. Collinwood, Ohio.

The Flaming Arc Lamp.—The flaming arc lamp, using the so-called yellow carbons, after several years use principally as an advertising light, is now being used to a considerable extent for the lighting of foundries, machine shops, etc., where the rooms are high, and where it is desirable to hang lamps above the crane. The characteristic distribution of this lamp as now built is particularly adapted to high buildings since the maximum light is thrown directly downward. The light is very powerful, and suited for lighting large areas when hung high. When placed too low the light would be glaring and inefficiently distributed.—*G. H. Stickney on "Illumination for Industrial Plants" in Proceedings of the Am. Inst. of Electrical Engineers.*

Lubricating Oil Consumption by the Railroads.—The "Report of the Commissioner of Corporations on the Petroleum Industry," in the issue of August 5, 1907, stated that 94 railroads paid out the enormous sum of $4,068,557 for lubricants during the period of one year, in or about 1905, and that the Pennsylvania System alone spent $385,933 for a similar purpose during a like interval.—*A. D. Smith before the Railway Club of Pittsburgh.*

POWERFUL FREIGHT AND PASSENGER LOCOMOTIVES FOR A NARROW GAUGE RAILWAY.

GENERAL DESCRIPTION OF A MALLET COMPOUND 2-6-6-2 TYPE AND A PACIFIC TYPE LOCOMOTIVE RECENTLY CONSTRUCTED FOR THE CENTRAL SOUTH AFRICAN RAILWAYS BY THE AMERICAN LOCOMOTIVE COMPANY. THIS RAILWAY HAS A 3 FT. 6 IN. GAUGE AND THESE LOCOMOTIVES ARE AMONG THE MOST POWERFUL EVER PUT INTO SERVICE ON A NARROW GAUGE ROAD.

About a year ago the American Locomotive Company built a 2-6-6-0 type locomotive 3 ft. 6 in. gauge for the Natal Government Railways of South Africa. This engine has been in service for several months and has fully met the expectations of the owners and proved most efficient and successful under the conditions existing on that road. On a 3.3 per cent. grade it easily handles 325 long tons, which is fifty per cent. more than the heaviest engines of other types can haul. It passes through 19.5 deg. curves with less flange friction than do eight coupled locomotives with rigid wheel base.

This company has recently completed another narrow gauge Mallet, that is to be put into service on the Central South African Railways, the conditions of which are very similar to those of the Natal Government Railways; the design in this case, however, being of the 2-6-6-2 type. In the same order are also included a large Pacific type locomotive, which in general design follows American practice and is provided with a fire tube superheater.

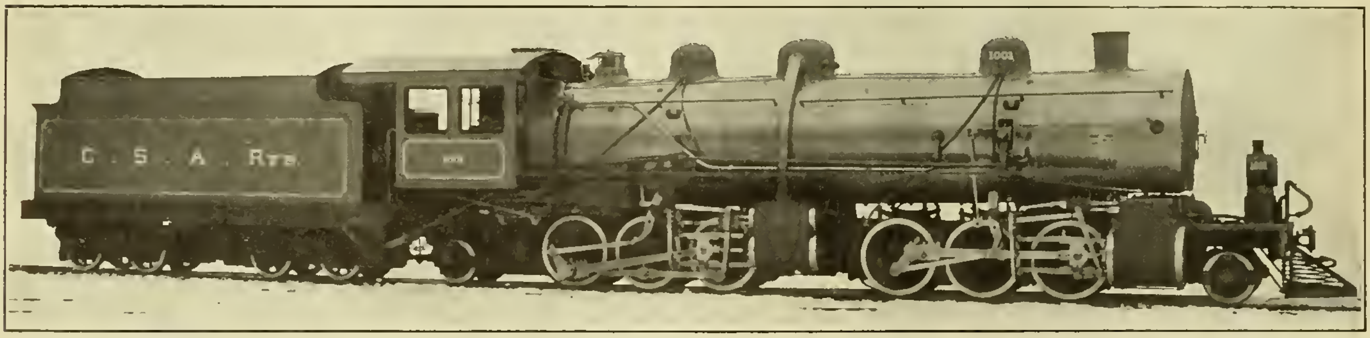
Referring first to the Mallet articulated compound locomotive. It has a total weight of 225,000 lbs., of which 192,500 lbs. is carried on the driving wheels. As far as the features peculiar to the articulated type of construction is concerned, the design in general follows the builders' standard practice. The high pressure cylinders are 18 inches in diameter by 26 inches stroke, and the low pressure cylinders are 28½ inches in diameter by the same stroke. The exhaust passages of the low pressure cylinders are carried forward to the front of the cylinder, where they connect to the branches of a "Y" pipe. This has a ball joint connection with an elbow connected by a pipe fitted with a slip joint with an elbow having a ball joint connection with the exhaust pipe in the smoke box. This arrangement was necessary in order to secure a proper length of flexible exhaust pipe so as to reduce the angle of its deflections when the locomotive passes through sharp curves. In order to provide room between the top of the cylinder casting and the smoke box for the flexible exhaust pipe it was necessary in this case to provide an offset of 5⅜ inches in the bottom of the smoke box from a point 15½ inches back of the center line of the exhaust pipe.

Following the usual practice, the high pressure cylinders are equipped with piston valves and the low pressure with Allen-Richardson balanced slide valves, both being operated by a simple design of the Walschaert valve gear.

The reversing mechanism is so arranged that the weights of the parts of the two sets of valve motions counter-balance each other. Reversing is effected by means of the builders' usual design of power reversing gear, except that in this case the reversing cylinder is operated by steam, as this engine is not equipped with compressed air.

Wrought iron frames four inches wide are used. The rear frames have a single front rail integral with the main frame, while the front frames are fitted with double front rails. There is a single articulated connection between the front and rear engines. That part of the weight of the boiler carried on the front system is supported by a single self-adjusting sliding bearing provided with the builders' usual design of spring centering device.

The three pairs of driving wheels of the front system are all equalized together and with the leading truck by a single central equalizing beam, while the rear set of driving wheels are equalized in a similar manner except that the cross equalization is omitted and each side is equalized with the trailing truck by means of an equalizing beam which fits into a pocket in the truck center pin. This arrangement gives a three point suspended engine.



NARROW GAUGE MALLET COMPOUND LOCOMOTIVE—CENTRAL SOUTH AFRICAN RAILWAY.

The boiler is of the radial stayed straight top type and the barrel measures 72½ inches in diameter inside at the first ring. The design incorporates an 18 inch combustion chamber, the bottom of which is laid with fire brick.

There are 271 tubes 2¼ inches in diameter and 20 feet long, which provide a heating surface of 3,167.7 sq. ft. The total heating surface of the boiler is 3,324.8 sq. ft. This gives a ratio of total heating surface to the volume of equivalent simple cylinders of 281. The firebox is 107 15/16 inches long and 66 inches wide, and provides a grate area of 49.5 sq. ft. Following English practice, the inside firebox is made of copper, the crown and side sheets being in one piece, and copper staybolts are used for the water-space stays.

Both trucks are of the radial center bearing, swing bolster type, with journals outside of the wheels. The bolster is suspended by 3-point or stable equilibrium hangers. The frame, which is of cast steel, of light but strong construction, is in three parts. The main frame has two arms on each side which extend outside of and partially surround the wheel, and between the ends of these arms the section forming the pedestal for the journal box is securely bolted. Coil springs seated on top of the boxes transmit the loads to the journals.

As the engine is designed to pass through curves of 350 feet radius it was necessary, in order to provide the required truck swing and bring the point of support as low as possible, to suspend the bolster underneath the axle and employ a long center pin, which is built up in two parts, the lower one straddling the axle.

The Pacific type locomotive is the heaviest narrow gauge passenger engine on our records, and in working order has a total weight of 155,000 pounds, of which 106,000 pounds are carried on the driving wheels.

The design was prepared by the builders and follows, in general, American locomotive practice, which will afford an excellent opportunity for determining the relative efficiencies of the English and American designs by a comparison of the results obtained with the engine here illustrated and others of the same type built by English locomotive manufacturers.

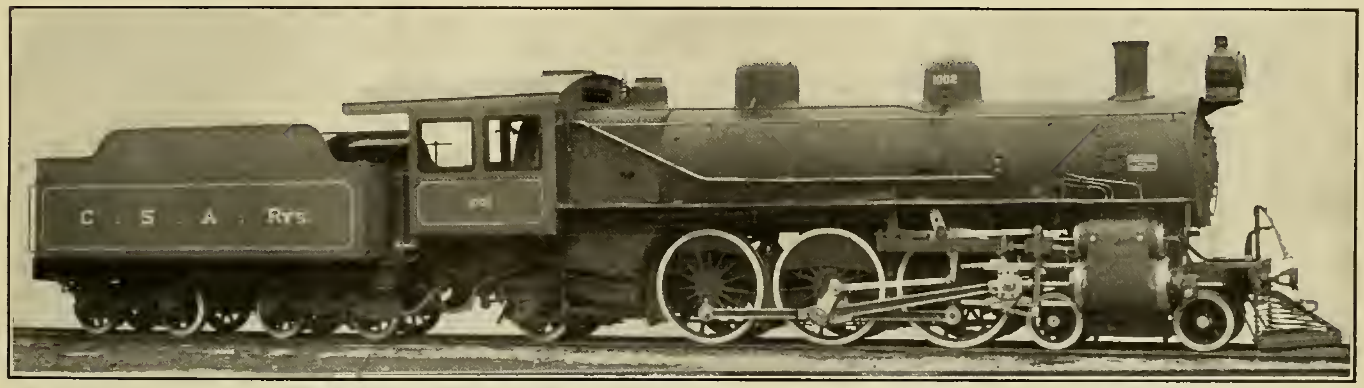
With 62 inch driving wheels and a maximum tractive effort of 28,800 pounds, the most difficult problem in connection with this design was to provide sufficient boiler capacity to meet the requirements without exceeding the maximum allowable height of 7 ft. 8 in. from the top of the rail to the center of the boiler. In this case the difficulty was very satisfactorily overcome by the application of highly superheated steam.

The superheater is the builders' latest design of fire tube type with side steam headers and of the double loop type arranged to give a high degree of superheat. It provides a heating surface of 363 square feet. This is 19 per cent. of the tube heating surface, which approximates very closely the ratio recommended by German locomotive designers, in which country the application of superheated steam has reached its highest development.

relation to the main and truck frames and in proper alignment with and full bearing on the journal boxes. This construction eliminates the necessity for outside supplementary trailing frames, thereby effecting a considerable reduction in weight, which in standard gauge trucks amounts to from 2,500 to 3,000 pounds.

The spring seat fits freely in a central opening formed in the spring seat guide and is carried on a trunnion block which passes freely through a longitudinal opening in the spring seat, and is provided with pivot ends carried in bearings bolted to the under side of the spring seat guide. The trunnion block is coupled to the spring seat by means of a transverse pin passing through both, the whole thus forming a universal joint connection. With this construction the spring seats can easily adjust themselves to any change in the position of the journal boxes relatively to the main frame. The spring seat guide slides between the jaws of the cast steel yoke, thus providing for the rise and fall of the journal boxes relatively to the main frame. Between the spring seat and the top of the journal box is interposed a cast iron friction plate. The upper surface of this plate is designed to form three inclined surfaces, the central sloping in an opposite direction to those on each side, but at the same angle. The corresponding surfaces of the spring seat are similarly inclined. This provides double inclined bearing surfaces, the action of which furnishes a resistance to the transverse movement of the truck, and assists the spring centering device in restoring the truck to its normal position when the locomotive enters a tangent after passing through a curve.

A boiler of the Belpaire type with a copper firebox in accordance with the usual English practice has been used. The throat sheet and back head are inclined so as to throw the center of gravity as far forward as possible, thereby bringing more weight on the driving wheels and reducing the load on the trailing truck.



POWERFUL NARROW GAUGE PACIFIC TYPE LOCOMOTIVE—CENTRAL SOUTH AFRICAN RAILWAY.

Full advantage has been taken of the application of highly superheated steam to use large cylinders and a low boiler pressure. The cylinders are 21 inches in diameter by 28 inch stroke, and the boiler carries a working pressure of 170 pounds per square inch.

Ten inch piston valves are employed; and following the most approved practice, both the valve and piston rods are provided with front extensions.

An interesting detail of the design is found in the new arrangement of the piston rod extension guide, which is so constructed as to be self-centering.

Another interesting feature of the design is the trailing truck, which is a modification of the company's new design of outside bearing radial truck that has been successfully applied to a number of recent Pacific type locomotives built by them. In the truck here applied the modification consists in the use of a spring yoke rigidly secured to the slab frame instead of one hinged to the frame. The important advantages of this type of trailing truck, as compared with the older type of outside bearing radial truck, are: greater simplicity of construction, material reduction in the dead weight of the engine, and a more perfect maintenance of the springs in their normal

The fire box is 78 inches long and 65 inches wide, and provides a grate area of 35 square feet. This gives a ratio of grate area to equivalent heating surface of 70.6. The firebox is supported by a steel expansion plate at the back end, while the support for the front end is furnished by a steel waist plate located just back of the rear pedestal.

The tender is of the 8-wheel type, being fitted with a U shaped tank having a water capacity of 4,000 gallons and space for 10 English tons of coal. The tender trucks are of the equalized pedestal type.

Steam brakes are applied to all the drivers, and in addition the engine is equipped with a vacuum brake which acts on the tender wheels and is provided with a connection for the train line.

The principal ratios and dimensions of both designs are given in the following table:

GENERAL DATA.

Type	2-6-6-2	4-6-2
Gauge	3 ft. 6 in.	3 ft. 6 in.
Service	Freight	Passenger
Fuel	Bit. Coal	Bit. Coal
Tractive effort	48,100 lbs.	28,800 lbs.
Weight in working order	225,000 lbs.	155,500 lbs.
Weight on drivers	192,500 lbs.	106,000 lbs.
Weight of engine and tender in working order	352,000 lbs.	259,800 lbs.

Type	2-6-6-2	4-6-2
Wheel base, driving	8 ft. 4 in.	11 ft. 2 in.
Wheel base, total	40 ft. 3 in.	29 ft. 8 in.
Wheel base, engine and tender	65 ft. 6 in.	54 ft. 11¾ in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.09	3.68
Total weight ÷ tractive effort	4.68	5.40
Tractive effort × diam. drivers ÷ heating surface	666.00	901.00
Total heating surface ÷ grate area	67.00	56.60
Firebox heating surface ÷ total heating surface, %	4.70	6.70
Weight on drivers ÷ total heating surface	57.80	53.50
Total weight ÷ total heating surface	67.60	78.50
Volume equiv. simple cylinders, cu. ft	11.80	11.20
Total heating surface ÷ vol. equiv. cylinders	281.00	177.00
Grate area ÷ vol. equiv. cylinders	4.20	3.12
CYLINDERS.		
Kind	Compound	Simple
Diameter and stroke	18 & 28½ x 26 in.	21 x 28 in.
VALVES.		
Kind, H. P.	Piston	Piston
Kind, L. P.	Slide	—
Greatest travel, H. P	5 in.	5½ in.
Greatest travel, L. P	5½ in.	—
Outside lap, H. P	1 in.	1 in.
Outside lap, L. P	⅞ in.	—
Inside clearance	3/16 in.	⅛ in.
Lead in full gear	3/16 in.	¼ in.
WHEELS.		
Driving, diameter over tires	46 in.	62 in.
Driving, thickness of tires	3 in.	3 in.
Driving journals, main, diameter and length	8 x 10 in.	9 x 10 in.
Driving journals, others, diameter and length	8 x 10 in.	8 x 10 in.
Engine truck wheels, diameter	28½ in.	28½ in.
Engine truck, journals	5½ x 10 in.	5 x 8 in.
Trailing truck wheels, diameter	28½ in.	33 in.
Trailing truck journals	5½ x 10 in.	6 x 12 in.
BOILER.		
Style	Straight	Belpaire
Working pressure	200 lbs.	170 lbs.
Outside diameter of first ring	73¾ in.	62 in.
Firebox, length and width	108 x 66 in.	78 x 65 in.
Firebox plates, thickness	½ in.	½ in.
Tube plates, thickness	1 & ½ in.	1 & ½ in.
Firebox, water space	F. 4, S. & B. 3½ in.	F. 4, S. & B., 3 in.
Tubes, number and outside diameter	271—2¼ in.	132—2¼ in.
Tubes, length	20 ft.	18 ft. 2 in.
Heating surface, tubes	3,167.7 sq. ft.	1,848 sq. ft.
Heating surface, firebox	156 sq. ft.	135 sq. ft.
Heating surface, total	3,324.2 sq. ft.	1,981 sq. ft.
Superheater heating surface	—	363 sq. ft.
Grate area	49.5 sq, ft.	35 sq. ft.
Smokestack, diameter	17 in.	14½ in.
Smokestack, height above rail	12 ft. 10⅜ in.	12 ft. 9¼ in.
TENDER.		
Wheels, diameter	33½ in.	33½ in.
Journals, diameter and length	5½ x 10⅛ in.	5 x 9 in.
Water capacity	5,000 gals.	4,000 gals.
Coal capacity	10 long tons	10 long tons

AN ELECTRIC STORAGE BATTERY CAR

Edison nickel-iron storage batteries have been in use for several years in automobile service with excellent results and have recently been arranged for driving street cars, the illustration showing the exterior and interior appearance of a car, which has been in experimental use for several months and has recently been put into service on the 28th and 29th street lines in New York City, displacing some of the horse cars. It has been found to work well on grades of 8 per cent. and has been driven up a 10 per cent. grade. The cost of current in this service has proven to be but two cents per car mile.

It is of the single truck vestibule type, the body being very carefully designed to obtain minimum weight. There are no body end doors, the vestibule being completely closed instead. Hand rails of white enameled steel have been installed to serve in place of straps, to help carry the roof and to hold the lighting fixtures. The lighting wires are enclosed in these tubes and no lighting fixtures are carried from the extremely light roof.

The car body is mounted on a single four-wheel truck of 6 ft. 6 in. wheelbase. The truck frame is of steel shapes welded at all joints by the oxy-acetylene process. The journal housing and all castings are of steel. The bearings are of the ordinary railway type, but were ground with extra care. The truck axles are of 2½-in. diameter steel and are divided in the center, a steel aligning sleeve being provided to permit the free rotation of each wheel with respect to its mate, as in automobile designs. It is believed that considerable power will be saved by using this form of axle. The wheels are of steel 28 in. diameter. Telescope steel spring seats are provided between the truck and the car body, thereby giving a free upward movement, but confining the side and end swaying to within ⅛ in. This reduction in the side and end movement has also greatly simplified the braking mechanism.

The batteries are placed under the longitudinal seats in a lattice steel electrically-welded girder frame weighing 153 lb. The frame on each side forms a box for the batteries, a support for the side posts and a firm bracing for the entire car. Each frame is bolted to the adjacent cross sills, side sills, side posts and end bulkheads, and through its connection with the vertical hand rails it helps to carry the roof. It has been found that, as a result of this novel construction, there is only a deflection of .003 in. when the car body carries a load of two tons in the center.

The storage battery consists of 200 type A-4 cells for traction and 10 cells for lighting. These cells are separately connected when working, but are in series when they are being

STORAGE BATTERY STREET CAR.

charged. This arrangement keeps the lights immune from variations in voltage when the car is running. The capacity of the battery is such that it can run the car for 150 miles without recharging. The motor equipment now mounted on the truck consists of two 5-h.p. 110-volt motors of Northern Electric manufacture, capable of attaining a maximum speed of 15 m.p.h. and a scheduled speed of 8 m.p.h. when there is an average of 14 stops per mile. The motors are connected to opposite axles by Renold chains. The truck can be used to carry four motors driven independent, one for each wheel, if desired. The controllers are of the Cutler-Hammer type arranged as follows: First step, batteries in multiple at 50 volts, motors in series;

INTERIOR SHOWING STORAGE BATTERIES UNDER THE SEATS.

second step, batteries in multiple at 100 volts, motors in series; third step, batteries at 100 volts, motors in multiple. It will be understood that no fixed resistances are used as the voltage is built up through cell combinations. The power consumption of this car when accelerating at 1 m.p.h.p.s. is about 3½ kw. and when running about 1½ kw. The weights of the several parts are as follows: Car body, 3,500 lb.; truck and electrical equipment, including two motors, 3,500 lb.; batteries, 3,000 lb. Adding the weight of 26 seated passengers at 150 lb. each, gives the equipment a total weight of 13,900 lb.

The car body, truck and equipment were designed by Ralph H. Beach, of the Edison Storage Battery Company, New York.

SIGNAL INSTRUCTION CARS.—The Pennsylvania Railroad has just equipped the divisions between Philadelphia and Pittsburgh with cars fitted with apparatus for giving instruction and examination in signals of all kinds.

THE RAILROAD CLUBS.

CLUB	NEXT MEETING	TITLE OF PAPER	AUTHOR	SECRETARY	ADDRESS
Canadian	May 3	Annual Meeting, Election of Officers		Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	May 13	Present Status and Tendencies of Railroad Electrification in America	F. Darlington	H. D. Vought	95 Liberty St., New York
New England	May 10			G. H. Frazier	10 Oliver St., Boston, Mass.
New York	May 20	Inequalities of Expansion in Locomotive Boilers and Possibilities of Eliminating the Bad Effect Therefrom	D. R. McBain	H. D. Vought	95 Liberty St., New York
Northern	May 28	Traffic	G. Roy Hall	C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	May 20	Steam Turbines	E. M. Herr	C. W. Alleman	P. & L. E. R. R. Gen. Office, Pittsburgh, Pa.
Richmond	May 9	Entertainment		F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	May 19			A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	May 13			B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	May 17			J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	May 9	Should the Brake Power on Freight Cars Be Increased?	Thos. Clegg	W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

M. C. B. RULES OF INTERCHANGE.

NEW ENGLAND RAILROAD CLUB.

At the March meeting of this club a committee consisting of J. W. Marden, J. E. Sheehan, and Edmund Rice presented a report to the effect that the New England Railroad Club recommended a method of interchange known as "the repair, run or transfer system," which will make car owners responsible for the cost of repairs of all defects, except those caused by derailment or wreck. This report was discussed at some length, there being advocates of accepting it as it stood and also of amending it. The M. C. B. rules of interchange were very thoroughly discussed in this connection and it was finally voted to accept the report of the committee and forward it to the arbitration committee of the M. C. B. Association.

The annual report of the secretary showed a membership of 527 and the treasurer's report showed a balance of over $1,700 on hand. The following officers were elected: President, John Lindall, Supt. R. S. & S., Boston Elevated Ry.; vice-president, J. A. Droege, Supt., N. Y., N. H. & H. R. R.; treasurer, Chas. W. Sherburne.

THE STRESSES DEVELOPED BY COLLISION OF FREIGHT CARS.

NEW YORK RAILROAD CLUB.

Col. B. W. Dunn presented an excellent paper on the above subject at the April meeting of this club. The theory was discussed at some length and following this the results obtained by a series of tests on the Pennsylvania Railroad were presented. An abstract of this paper will be given in a later issue of this journal.

THE FUNDAMENTAL PRINCIPLES OF EFFICIENCY.

RAILWAY CLUB OF PITTSBURGH.

Harrington Emerson presented a brief but most comprehensive paper at the February meeting of this club. In it the laws governing the principles of efficiency were condensed to eight in number, each being named and briefly discussed by the author.

This paper was discussed at some length by L. H. Turner, whose remarks are well summed up in the following quotation: "Our country is suffering from too many 'short time record makers' giving short spectacular performances but who eventually sink into obscurity. Every mechanical man in charge of a large equipment is prompted not only by personal pride but by desire to maintain a good position among other lines for the cost of maintenance; he is willing and glad to follow any new methods that will aid him, but does not like to have impossible performances held up as a model for his guidance. The work in which Mr. Emerson is engaged should be prolific with good results, but we believe he has placed his standards too high and has aimed at results which can never be attained and in consequence are not taken seriously."

The paper was also discussed at some length by I. B. Thomas, William Elmer, P. J. Conlon, F. H. Stark, W. L. Kinsell, W. J. Powers, W. J. Schlacks, and others.

ECONOMY IN LOCOMOTIVE REPAIR SHOPS.

WESTERN CANADA RAILWAY CLUB.

W. R. Smith, general foreman of the Canadian Northern Railway shops, presented a paper on the above subject at the March meeting of this club. He considered a number of different features in connection with repair shops, where a little study would bring about very large savings. Among these were the use of the crane over the yard where heavy material is stored, doing away with the services of a large number of men, and the purchasing of the proper grade and quantity of material. The expense from delay of delivery of ordered material was shown to be very large and the matter of proper form for accounts was considered at some length, a description of the method being used on the Canadian Northern Railway being given. A spirited and general discussion, which added much to the value of the paper, followed its presentation. Men from all different departments suggested ways in which economies could be made.

ECONOMICAL AND PROPER HANDLING OF MATERIAL IN THE STOREHOUSE.

NORTHERN RAILWAY CLUB.

J. E. Chandler, storekeeper of the Duluth & Iron Range Railroad, presented a paper at the February meeting of the above club which briefly considered a few features in connection with the proper handling of storehouse material. Attention was drawn to improper practices that have become customary on most railroads.

ANNUAL MEETING.

ST. LOUIS RAILWAY CLUB.

At the annual meeting of the above club on April 8 the following officers were elected: President, E. A. Chenery; first vice-president, H. G. Pfeifer; second vice-president, Charles Burlingame; third vice-president, J. P. Carothers; secretary, B. W. Frauenthal; treasurer, C. H. Scarritt; members of executive committee, W. H. Elliott and Tipton Stilwell.

Secretary Frauenthal's annual report showed that the present membership is 1,185, and that the club has a balance in its treasury of $3,737.08. He stated that the present holder of the club's scholarship will graduate from the University of Missouri this year and that the executive committee desired to bring before the members the necessity of selecting another person for the scholarship and of designating the institution to which he shall be assigned, so that the members may aid the committee in taking proper action.

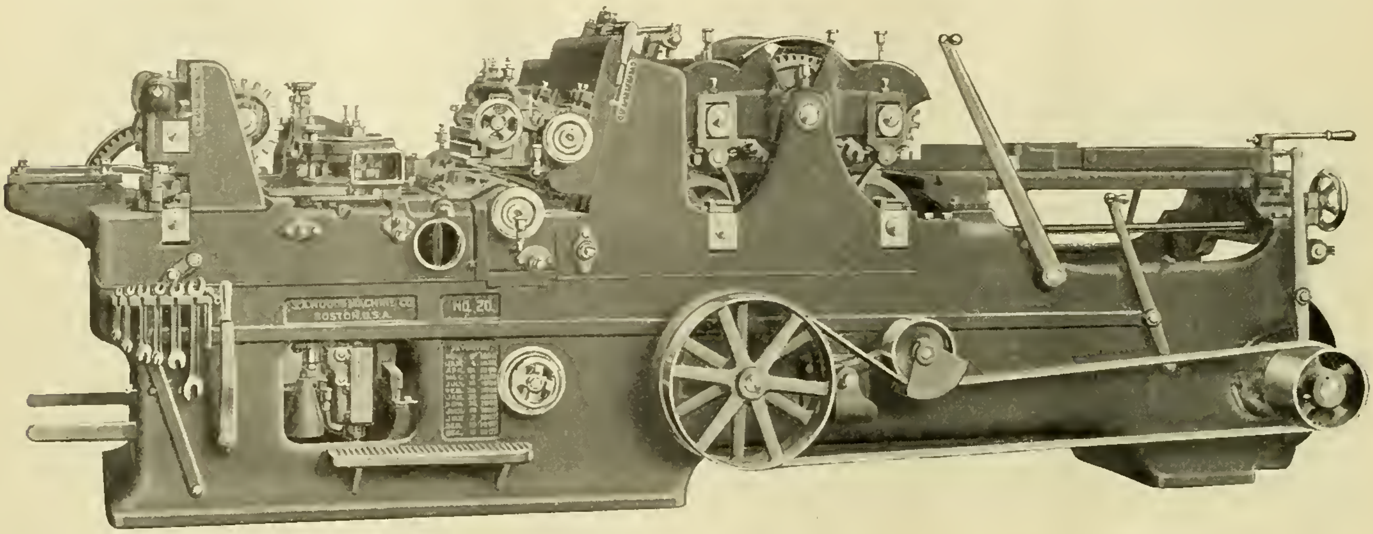
A DEPARTURE IN PLANING MACHINE CONSTRUCTION.

The rapid production and high grade finish demanded in the output of the modern planing mill and car shop has made necessary and induced the adoption and development of new features to displace many older features of construction that in the past had been accepted without question. But the possibilities of perfect cutterhead work and rapid feed have been appreciated within a comparatively short time, and the development of planing machines to take advantage of the latest devices is still more recent.

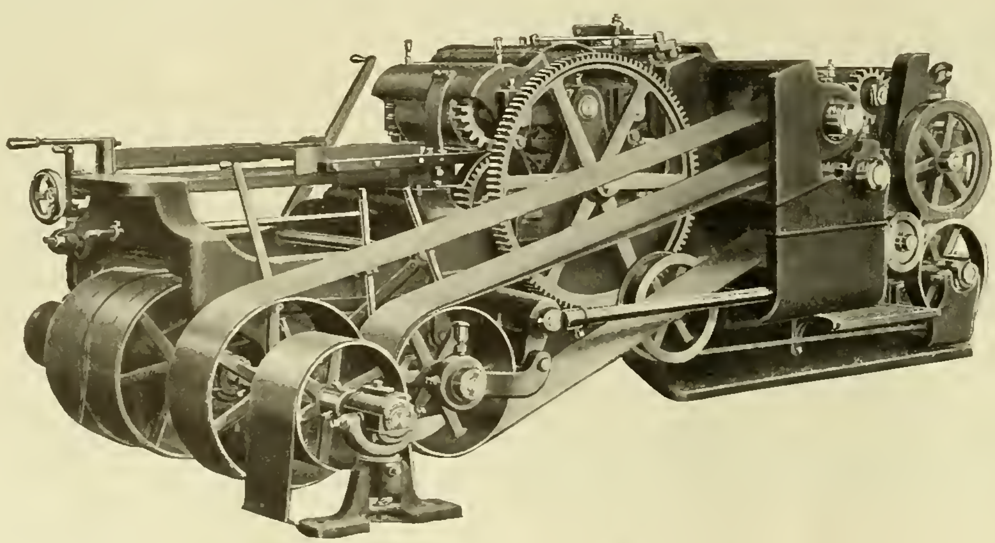
One of the greatest difficulties in obtaining perfect cutterhead work has been due to the almost impossibility of maintaining the proper condition in the cutterhead journals. It is known that under the high speeds of planing machine cylinders and the increased size of belts necessary for fast feed, the wear of the journals is very rapid and soon destroys the accuracy of any adjustment that may be made. Then again the lubrication of long cutterhead boxes has always been considered a very difficult problem and almost impossible of attaining to any degree of satisfaction or reliability. When it is considered that the pull of the cutterhead belts while working may be as high as 1,500 pounds and the journal speed as high as 3,200 feet per minute, under these strains it is not surprising that a great deal of difficulty is experienced.

Another element of the difficulty has been experienced in the vibrations and jars of the cutterheads caused by the belts on the shafts, this factor being one of the most serious and difficult to eliminate. It was not unusual to see the mark left by the belt lacing on the stock each time that it went over the pulley. The difficulty of making two belts run exactly alike also added to the troubles attending the method of belting cutterheads. The importance of the factor of belt slippage in the problem will be appreciated when it is considered that a difference of .01 of an inch in the diameter of the cutterhead pulleys means a difference of from ten to twelve feet in the amount of belt travel at the ordinary planing mill speeds, the difference being exaggerated by variations in thickness and tension of belts.

The necessity of the operator's working about the cutterheads in truing them off while they are running at full speed made the belting of cutterheads on the front or operating side of the machine somewhat dangerous, and accidents to operators have resulted from the breaking of belts while the operator was in the line of belting.

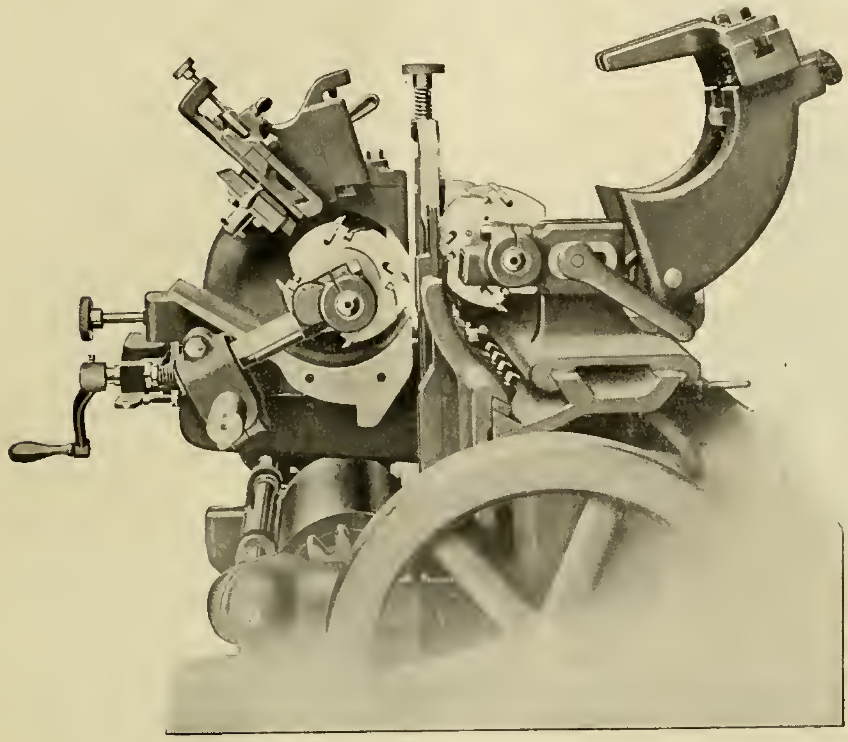


NEW PLANING MACHINE—S. A. WOODS CO.



REAR VIEW OF NEW PLANING MACHINE.

Convenience and accessibility on the operating side of any machine, allowing the removal of the cutterheads, taking out defective pieces, etc., are desirable. To accomplish these results, to eliminate the objectionable features of belting upon the cutterhead direct, and of belting troubles generally, the S. A. Woods Machine Company, Boston, Mass., has developed its one-side coupled drive, in which one belt is used for each cutterhead, and the belts are placed on the back side of the machine, each driving a cutterhead pulley supported by boxes entirely independent of the cutterhead itself, a connection being made between the two by a flexible coupling. This coupling is claimed to absorb all



BEADING OR PROFILING ATTACHMENT FOR PLANING MACHINES.

vibrations transmitted to the pulley by the belting, thus leaving the cutterhead journals without the strain of the belts or other disturbing influences.

This improvement permits the use of very short journals upon the cutterhead, these journals being efficiently lubricated by improved oiling devices, thus rendering easy the maintenance of ideal running conditions. This design also makes possible the instant detaching of the cutterhead from the spindle, leaving it free to be turned when setting up and without disturbing the belts in any way. Another new feature embodied in this one side driven planer is the new Woods Beading or Profile attachment which can be applied at the feeding out end of the machine. This new attachment carries all the knives for taking the formed cuts usually done on the top and bottom heads, and enables the operator to keep the full number of straight knives on these heads, ready for all classes of work. At the high speeds planers are now being run, when it is desired to work profile cuts with the formed knives on the top or bottom heads, it is necessary to greatly reduce the feeds. The new beading or profile attachment has been brought out to eliminate this.

The attachment is placed at the feeding out end of the machine and is made either single or double, as desired. The upper attachment is provided with a shoe or chip breaker, which rides upon the face of the stock, and is at all times positioned thereby. the cutterhead has a fixed relation to this shoe and any variation in stock does not effect the depth of cut taken. It will thus be seen that no damage can be done to the attachment if more than one piece of stock should be fed to it at a time. Vertical adjustment is provided for the cutterhead spindle, to regulate the cut. Both heads may be adjusted horizontally or vertically while in operation, and the attachment may be instantly put into or taken out of operation while the machine is running. Thus when it is desired to change from working siding or formed stock to flooring, or vice versa, the change is made very quickly. A detachable end bearing is provided for each spindle for steadying it, and suitable guides are furnished. The cutterheads are circular discs of steel, the width depending upon the size of cutters required. They are fitted with clamps and may be located at any point on the spindles. High speed steel cutters are used and quick means are provided for adjusting with relation to each other. The bottom table is arranged to swing down for accessibility to the heads.

The S. A. Woods Machine Company may be said to have fairly earned the title of "Planer Specialists" by concentrating its attention upon wood planers, and the No. 20 is the practical result of this specializing and the concrete demonstration of the higher efficiency to be attained through such concentration. Millmen who are contemplating the installing of planers will do well to look into this new type of machine.

HYDRAULIC BENDING MACHINE

For bending pipe, structural sections, metal bars, etc., the Watson Stillman Co., of New York, have recently perfected a very powerful hydraulic machine which is made in two sizes. The frames and cylinders are of cast iron, the latter being copper lined. The rams and bending pins are of machinery steel and a positive stop is provided to prevent the ram from passing out beyond a safe limit.

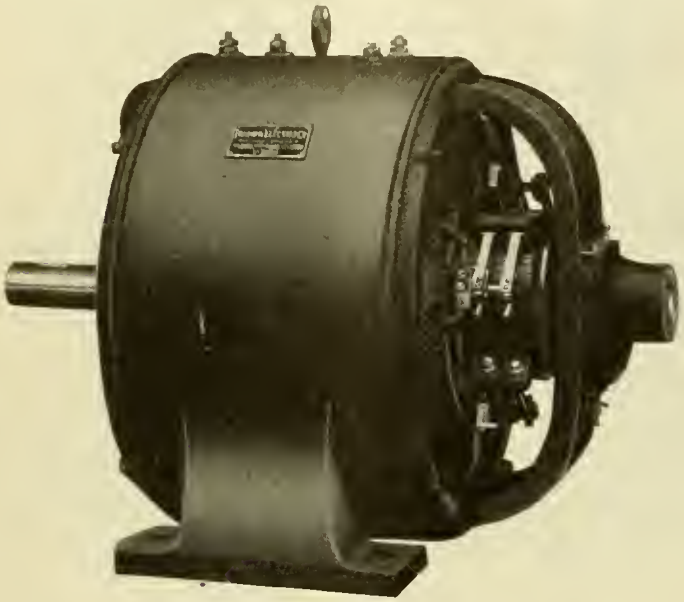
The illustration shows the smaller size of this machine, which is capable of exerting a power of 25 tons under a hydraulic pressure of 2,200 lbs. per square inch. The table is 2 ft. long by 3 ft. 4 in. wide and is provided with 18 round holes staggered in rows which are symmetrically placed with respect to the ram; 3½ in. diameter pins can be placed in any of the holes or the work can be held by bolts set in the slots on the top and sides of the table. The ram has a travel of 8 in. and is provided with a counterweight for bringing it back to the beginning of the stroke. Its center is customarily 2½ in. above the table, but can be varied if desired. The operation of the ram is controlled by a stop and release valve at the side of the cylinder.

HYDRAULIC PIPE BENDER.

The larger sized bender exerts a 30-ton pressure and has a table 4 ft. wide by 6 ft. long. In this case there are two opposed 7-in. cylinders of 12-in. stroke, arranged to operate in either direction. The double-headed ram extends between them and works in machined guides in the top of the table, its top being flush with that of the table. It carries a large vertical bending pin. The operation of this press can be controlled by levers at either corner of the table. It works in general in the same manner as the smaller size, the table having 21 holes staggered in six rows.

ADJUSTABLE SPEED MOTORS FOR DRIVING MACHINE TOOLS.

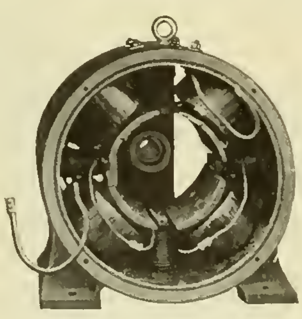
To successfully operate the majority of machine tools, a motor having a wide range of speed is desirable and such motors are now being specified very generally. To answer this demand



TRIUMPH CONSTANT SPEED MOTOR.

the Triumph Electric Company, of Cincinnati, has developed an adjustable speed motor, the special features of which are as follows: Wide adjustment of speed, constant speed maintained at any given speed, constant horse power at any speed, heavy overload capacity, and motor will run without sparking at any speed or load within the capacity of the motor and in either direction of rotation without shifting the brushes, which are immovably fixed.

The sparkless feature is obtained by means of commutation poles placed midway between the main field poles and wound with coils in series with the armature, so that the strength of these poles depends upon the load on the motor and is therefore



SECTIONAL VIEW OF TRIUMPH CONSTANT SPEED MOTOR SHOWING COMPENSATING COILS.

proportional to the armature reaction. This is true irrespective of the direction of rotation, so that the points of commutation are always in a field of such magnetic strength that sparkless commutation at all loads and all speed variations is obtained. This method of construction permits heavy overloads to be carried with ease and safety.

The illustration shows one of these motors with the front bracket removed and reveals the commutation poles. The absolutely sparkless operation insures long life for the commutator, smoother running for the motor, and less wear and tear on the brushes. Higher efficiencies are also obtained, due to the lower iron and commutator losses.

These motors develop the greatest torque at the lowest speed, and since the majority of machine tools require a heavy starting torque, they are especially suited for this purpose.

MEN WANTED.

Young technical graduates to learn the steel foundry business; excellent opportunity for men of the right character; also draftsmen experienced in railroad designing.

POSITIONS WANTED.

Designer with a railroad supply company; has had long and very thorough experience in railroad shops and drafting rooms and can furnish excellent references as to ability; at present chief draftsman with one of the largest railway systems.

Assistant to Superintendent of Motive Power or General Inspector—Man with 20 years' railroad experience; technical education; has held all positions, from fireman to master mechanic, and from machinist to mechanical engineer; a hustler who can show results; is an expert on fuel tests, spark throwing, front end and draft arrangements.

Mechanical Engineer or Chief Draftsman.—Has had long experience in the drafting room of railways principally in the South and Southwest; is at present chief draftsman on one of the systems in the latter territory.

Chief Draftsman, or outside work requiring similar qualifications by a technical man; seven years' railroad experience; now employed on a western railroad as leading draftsman on locomotive and electrical work.

Master Mechanic or general inspector; technical man with 15 years valuable general experience; occupied position as round house foreman, general piece work inspector, general foreman, master mechanic, general inspector, assistant city editor and financial editor on metropolitan paper, wishes position after July 10, when he will return from a tour of inspection on foreign railroads.

Chief Draftsman, or assistant master mechanic; Purdue graduate, experienced in all motive power departments; served as roundhouse foreman, shop investigator and other similar positions; is willing to go into the supply business, but prefers railroad work; salary over $150 per month.

BOOK NOTES.

Engineering Index Annual, 1909. Bound in cloth. 471 pages. 6½ by 9½ in. Published by the *Engineering Magazine*, 140 Nassau street, New York. Price, $2.00.

This forms the fourth volume of the annual and the eighth in the series of the index, which combined gives a continuous index of the engineering and technical literature for the past 26 years. While in general it follows the same scheme of classification that has proved so successful in previous annuals, the classification in this volume has been somewhat amplified and cross references have been more freely used. It incorporates references to practically every article of value that has appeared in any of the scientific or technical magazines during the past year and is based upon the monthly indexes published in the *Engineering Magazine*. The fact that it has not been found advisable to change the classifications is a good indication of their satisfactory arrangement and selection. No engineer's library can possibly be considered complete without a set of these indexes.

Valve-Setters' Guide. By James Kennedy. Cloth. 5½ by 7 in. 57 pages. Illustrated. Published by Angus Sinclair Co., 114 Liberty street, New York. Price, 50 cents.

This book considers at some length the construction and adjustment of the principal valve gears used on American locomotives. It describes the arrangement of the different designs by means of illustrations and contains instructions for the proper procedure in setting valves with each.

PERSONALS.

H. F. Smith has been appointed a master car builder of the Chicago & Alton R. R., with office at Bloomington, Ill.

J. M. Burke has been appointed district master mechanic of the Atlantic division, Canadian Pacific Ry., with office at Brownsville Jct., Me.

C. W. Van Buren has been appointed master car builder of the eastern lines of the Canadian Pacific Ry., with office at Montreal, Que.

Charles H. Bilty has been appointed mechanical engineer of the Chicago, Milwaukee and St. Paul Ry., succeeding J. F. DeVoy, promoted.

F. F. Patterson has been appointed district master mechanic of the western division, Canadian Pacific Ry., with office at Moose Jaw, Sask.

H. G. Huber, assistant master mechanic of the Pennsylvania R. R. at Philadelphia, has been transferred to Harrisburg, succeeding W. J. Rusling.

R. A. Pyne, master mechanic of the Canadian Pacific Ry. at Nelson, B. C., has been transferred to Calgary, Alta., succeeding W. E. Woodhouse, promoted.

W. L. Harrison, superintendent of motive power of the Northern district, Rock Island Lines at Cedar Rapids, Iowa, has resigned to enter into private business.

E. H. Wade, master mechanic of the Chicago & North Western Ry. at Chicago, has been appointed supervisor of locomotives, with office at Green Bay, Wis.

C. M. Taylor, superintendent of motive power of the Rock Island Lines at Shawnee, Okla., has had his jurisdiction extended over the entire Southern district.

W. J. Rusling, assistant master mechanic of the Pennsylvania Railroad at Harrisburg, Pa., has been appointed foreman of the Enola, Pa., shops, succeeding H. T. Coates, Jr., promoted.

P. A. Crysler, formerly general car inspector, Canadian Pacific Ry. Eastern Lines, has been appointed assistant general foreman of passenger car repair work at the Angus shops, Montreal.

D. T. Main, heretofore locomotive foreman on the Canadian Pacific Ry. at Cranbrook, B. C., has been appointed district master mechanic at Nelson, B. C., suceeding R. A. Pyne, promoted.

W. J. O'Neill, master mechanic of the Chicago, Rock Island and Pacific Ry. at Fort Worth, Tex., has been transferred to the Louisiana division at Eldorado, Ark., succeeding C. A. McCarthy.

Walter Liddell, general foreman in the locomotive department of the Chicago, Milwaukee and St. Paul Ry. at Dubuque, has been appointed master mechanic, succeeding J. J. Connors, promoted.

C. A. McCarthy, master mechanic of the Louisiana division of the Chicago, Rock Island and Pacific Ry. at Eldorado, Ark., has been transferred to the Arkansas division, with office at Argenta, Ark.

Tom Brown, formerly master mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona, has been appointed a special representative of the Westinghouse Air Brake Company, with headquarters at 165 Broadway, New York City.

Frank Hufsmith, formerly superintendent of motive power of the International & Great Northern Ry., has been made receiver of the Oklahoma, Red River & Texas Ry., with office at Palestine, Texas.

F. J. Harrison, division master mechanic of the Buffalo, Rochester & Pittsburgh Ry., has been appointed superintendent of motive power, with office at Du Bois, Pa., succeeding W. H. Wilson, resigned.

W. H. Williams, master mechanic of the Buffalo, Rochester & Pittsburgh Ry. at East Salamanca, N. Y., has been appointed master mechanic of the Middle and Pittsburgh divisions, with office at Du Bois, Pa.

T. J. Hamilton has been appointed district master mechanic of the Chicago, Milwaukee & Puget Sound Ry., with office at Deer Lodge, Mont. He will have charge of the line between Harlowtown, Mont., and Avery, Idaho.

J. J. Connors, district master mechanic of the Chicago, Milwaukee and St. Paul Ry. at Dubuque, Iowa, has been appointed assistant superintendent of motive power of the lines west of the Mississippi river, with office at Dubuque.

James F. DeVoy, mechanical engineer of the Chicago, Milwaukee & St. Paul Ry. at Milwaukee, Wis., has been appointed assistant superintendent of motive power of the lines east of the Mississippi river, with office at Milwaukee.

F. W. Williams, superintendent of motive power of the Southern district of the Rock Island Lines at Fort Worth, Tex., has been transferred to the Northern district, with office at Cedar Rapids, Iowa, succeeding W. L. Harrison, resigned.

E. J. Harris, master mechanic of the Iowa and Des Moines Valley divisions of the Rock Island Lines at Valley Junction, Iowa, has been appointed master mechanic of the Kansas City Terminal and the St. Louis division at Armourdale, Kan.

T. W. McCarthy, master mechanic of the Arkansas division of the Chicago, Rock Island and Pacific Ry. at Little Rock, Ark., has been appointed master mechanic of the Indiana Territory and the Pan Handle divisions, with office at Shawnee, Okla.

LeGrand Parish, who since 1906 has been superintendent of motive power on the Lake Shore and Michigan Southern Ry., has resigned to accept the presidency of the newly organized American Arch Co., which hereafter will conduct the business of the American Locomotive Equipment Co. of Chicago and the brick arch department of the Franklin Railway Supply Co. Mr. Parish was born at Friendship, N. Y., in 1866. His railroad career has been one of unusual activity and brilliancy. He entered the service of the Lake Shore and Michigan Southern in 1889, since which time he has been chief clerk of the car department, general foreman, master car builder, assistant superintendent of motive power, and superintendent of motive power. His remarkable rise can be attributed largely to his unusual ability as an organizer. For a number of years Mr. Parish has taken an active part in the affairs of the Master Car Builders' and the Master Mechanics' Associations. At present he is second vice-president of the former and he also, at one time, served a term as president of the Western Railway Club. The officers of the American Arch Company are: J. S. Coffin, chairman; LeGrand Parish, president; Charles B. Moore, vice-president; Samuel G Allen, secretary and treasurer. The principal office of the company will be at 30 Church street, New York, with branch offices at Chicago, St. Paul, Omaha, Denver, Los Angeles and at San Francisco.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Transite Asbestos Wood.—The uses of this wood are discussed in a circular from the H. W. Johns-Manville Company, New York City. It is said to give splendid results when used for smoke jacks.

Valves.—A new leaflet is issued by Jenkins Bros., New York, describing their quick opening Globe and Angle Valves. These valves are of the same high quality and similar in design to the regular Jenkins valves except that the spindles and bonnets are quadruple threaded with a coarse pitch.

Electric Forge Blower.—The B. F. Sturtevant Co. are sending out Bulletin No. 177, which illustrates and describes their new Electric Multivane Forge Blower. It is claimed that this method of forge blowing possesses many advantages over the method where a larger blower takes care of several forges.

Vertical Turret Lathes.—A very interesting pamphlet marked V-16, entitled "The Vertical Turret Lathe for Machining Automobile and Gas Engine Parts" describes this new tool made by the Bullard Machine Tool Co., Bridgeport, Conn. It also contains a number of very good line drawings showing clearly the different operations in machining such parts.

Wood's Locomotive Fire Box.—A pamphlet is being issued by the William H. Wood Locomotive Fire Box & Tube Plate Company, Media, Pa., which is given up largely to the reproduction of letters from various railroad men concerning service and opinions on the value of this type of fire box for locomotive use. These letters are, in general, very complimentary to the value of this type of construction.

Burning Fuel Oil.—The Springfield process for burning fuel oil under low pressure is very fully explained in an attractive manner by a catalog being issued by Gilbert & Barker Mfg. Co., Springfield, Mass. This process is remarkably simple and is largely automatic. It gives practically perfect combustion with furnaces which require no combustion chamber and are large enough for the material to be heated and no larger.

Motor Cars.—Fairbanks, Morse & Co., Chicago, have just issued a very artistic catalog showing their gasoline motor cars, both for passenger service and inspection purposes. The catalog is probably one of the best books of its nature ever issued and is particularly interesting because the cars shown represent the progress in the manufacture of gasoline cars for track use, including the different types for all requirements of railroad work.

Barium-Choloride Furnace.—A leaflet is being issued by the Rockwell Furnace Co., New York, illustrating and describing the Barium-Choloride furnace that uses either oil or gas fuel for heating high speed steel tools, milling cutters, taps, dies, etc., for hardening. It will maintain a bath at uniform temperature that is under the accurate control of the operator, and largely eliminates the risk usually experienced in hardening high speed tool steels.

Rotary Converters.—Bulletin No. 4723, recently issued by the General Electric Co., gives a very good description of the regulating pole rotary converter, which they have developed to simplify the wiring arrangements and to reduce the cost of auxiliary devices where the use of converters in connection with electric lighting and industrial power plants necessitates a variable ratio between the alternating and direct current voltages for charging storage batteries and other special requirements.

Bolt Cutters.—Catalog No. 46 from the Newton Machine Tool Works, Philadelphia, describes a new Multiple Automatic Die Head very suitable for round house and repair shop work. This head is flexible in that it is fitted with chasers which are interchangeable, for four sizes of bolts, yet retaining the rigidity and accuracy of a solid die. The catalog also contains some good illustrations of bolt threading machines, rotary planers, cold saws, horizontal milling machines, and a duplex rod boring machine.

Tool Steel.—Number 10 of "Ryerson's New Technical Library," being issued by Joseph T. Ryerson & Son, Chicago, is a 64-page booklet containing a complete description of the various kinds of high speed and carbon tool steel that is handled by that company, together with complete directions for treating to insure the best results. In addition there are several pages devoted to tables of useful information in connectinn with steel. This company handles thirteen different kinds of tool steel, several of which can be obtained in different grades.

Bolt Cutting and Forging Machines.—The Acme Machinery Co., Cleveland, O., is issuing a standard size catalog containing 162 pages given up to illustrations and descriptions of bolt cutting, nut tapping and forging machines. The detail construction of each of these machines is clearly shown by wash drawings and is discussed in a very thorough and interesting manner on adjoining pages. The processes of manufacture are considered in most cases, indicating the care with which the machines are made. Bolt cutters in many sizes and capacities are shown that are fitted with the new special adjustment Acme die heads, which are said to be the most important advance made in the construction of these machines in a long time. The nut tappers are illustrated in a similar manner, as are also the forging machines. This is a most interesting and valuable catalog.

Boring Mills.—Vertical boring and turning mills in any size ranging from 30 to 84 inch, inclusive, are attractively presented in a catalog just issued by the Gisholt Machine Company, Madison, Wis. The smaller size have a single swivel head and are driven by a 4 step cone pulley, giving 16 table speeds available through the head stock and two speed counter shaft. The larger machines have a total of 12 table speeeds. Any of these machines, however, may be motor driven if desired. The catalog is arranged with an excellent photograph of the machine on one page and the principal dimensions and a brief description on the facing page. It also includes illustrations showing the details of construction as well as the mills working on some locomotive parts. There are many new features on these mills that will be appreciated by the shop superintendent.

Keeping Shop Records of Belting.—The average railroad shop buys a large amount of belting each year, which is chopped up and put on various machines throughout its plant as belting gives out. Few plants keep any record of the actual length of service of the belts on any particular machine. At the end of a year's time it is not definitely known whether the belt equipment for the various kinds of machinery in the shop has cost more than it should or not. No doubt railroad shops generally will be interested in a plan of keeping shop records which have just been gotten out by the engineers of the New York Leather Belting Company, 51 Beekman street, New York City. Charts have been printed, which can be tacked up on every floor in a factory, and, by merely filling in certain blanks, entailing little or no trouble, at the end of the year, the exact record of belts on every machine on that floor can be absolutely checked up. In this age of cost reduction systems, a system of shop belt records of this sort should be kept. The belt record charts of the sort described above may be had by applying to the above company.

NOTES.

Summers Steel Car Co.—On account of the increase in its business during the last year this company announces that it has recently changed its offices to 2312 Henry W. Oliver Building, Pittsburgh, Pa.

Cleveland Twist Drill Company.—After the first of May this company will move its Chicago branch to 9 North Jefferson street, where greatly improved facilities are afforded.

Firth-Sterling Steel Co.—It is announced that A. E. Barker has been transferred from the Chicago office to Birmingham, Alabama. E. S. Jackman & Co., 710 Lake street, Chicago, are the general agents for this steel.

Flannery Bolt Company.—It is announced that George E. Howard has been appointed eastern representative for the above company, general sales agent for the Tate Flexible Staybolt, with office at Pittsburgh, Pa.

Clement Restein Company.—This company, of Philadelphia, manufacturers of Belmont packings, have opened a branch office and stock room at No. 11 Woodward avenue, Detroit, Mich., with E. N. Marcy, who was formerly connected with its general office as manager.

Burton W. Mudge & Co., Railroad Supplies.—On May 1 this company will remove its office to temporary quarters in Suite 1003, People's Gas Building, Chicago, until such time as the southern portion of the same building is completed, when it will occupy offices overlooking Michigan boulevard and Adams street.

Pressed Steel Car Company.—Frederick Mortimer Robinson, who has been connected with this company for the past six years as sales agent, died of pneumonia on April 2 and was buried in Petersburg, Va., April 4. Mr. Robinson was 33 years of age and had formerly been connected with the Chesapeake & Ohio Railway Company.

Dearborn Drug & Chemical Works.—It is announced that after May 1, 1910, the general offices and laboratory of the above company will be located on the twentieth floor of the McCormick Building, Michigan avenue and Van Buren street, Chicago. On account of the extensive growth of its business it was found necessary to remove from its present quarters in the Postal Telegraph Building.

Boston Belting Company.—The company advises that its arrangements with the Jewell Belting Co. of Chicago to act as its Western agent have been terminated and announces that it has opened a store at 177 Lake street, Chicago, with M. S. Curwen, manager of sales, in charge of the same. They will carry in Chicago an even more complete assortment of rubber belting, hose, packings and other mechanical rubber goods than in the past.

Davis Bournonville Company.—This company, of 90 West street, New York, announces that the Ohio Welding & Mfg. Co., 828 West Sixth street, Cincinnati, Ohio, will act as its dealers. With this in view a large demonstrating plant has been installed, including not only the welding equipment, but also the oxygen plant. The repair work will include everything to which the oxy-acetylene process can be applied. This company will also shortly open a demonstrating and repair shop at 2121 East Second street, Cleveland, Ohio.

RAILROAD SHOP LAYOUTS

A DISCUSSION OF THE FEATURES THAT INFLUENCE THE RELATIVE LOCATION OF THE STRUCTURES THAT MAKE UP AN AVERAGE RAILROAD SHOP PLANT.

F. Kingsley.

The arrangement of the buildings comprising a complete railroad repair shop is a matter subject almost entirely to convenience in the handling of material. There are, of course, other considerations, but, in the main, if it were not for the difficulty and cost of transporting the vast number of parts entering into the construction of locomotives and cars, between the various shops, any arrangement of buildings would be satisfactory.

Manifestly, in cases where the shop site is restricted in size, conditions may arise whereby the desirability of convenient arrangement must be sacrificed to the necessity of getting all of the buildings into the space provided. However, such cases occur only where policy demands the retention of a shop within a large city where the cost of real estate is high, and present practice shows a decided trend away from the custom of loading shop costs with a heavy surcharge on account of excessive ground values. In the great majority of cases, when new shops are proposed, the ground area is, within reasonable bounds, unlimited.

In such cases of unrestricted area, similarity of practice on American railroads would point toward the possibility of a single ideal arrangement, unaffected by ordinary differences in conditions, and applicable in every case. Material handled between the various departments and buildings is much the same in character and relative quantity for every railroad shop in the country; and for this reason each new railroad shop can hardly be considered as an entirely new problem with characteristics materially different from shops already in existence. Existing shop arrangements, however, indicate that there is no tendency toward uniformity. It is safe to say that there are not half a dozen shops in the country having marked similarity of arrangement. Nevertheless, every shop layout is affected by the same set of general rules which are so well known, in fact, so self evident, as to be practically axiomatic.

There is, or should be, a sound reason for everything that is done. Advocating the application of perfectly obvious common sense rules to shop layouts may seem superfluous; but, on the other hand, many obvious truths about shop layouts are often neglected. For example, it would be difficult to find an argument against placing the storehouse and machine shop near together. A great deal of material in small lots is continually passing between the two buildings, especially where any manufacturing of standard pieces goes on. The desirability of adjacent locations is manifest, yet in a certain new shop, splendidly built and thoroughly organized, the storehouse is separated from the machine shop by a transfer table. Naturally, this results in a large and cumbersome sub-store in the machine shop, requiring double handling and charging of much material and occupying valuable floor space. The transfer table in front of the blank storehouse wall is exactly comparable to the proverbial fifth wheel on a wagon.

Another case of divergence from a perfectly obvious rule is found in another modern shop where the power house and the blacksmith shop are at extreme opposite sides of the group of buildings. The primary result has been that the pipe tunnel required for the live steam line to the steam hammers has alone cost as much as a good sized building, to say nothing of the cost of the pipe and the continuous loss due to condensation. At the same shop the storehouse is found so close to the power house as to constitute a bad fire risk, and yet if there is any pair of buildings which can be separated without sacrificing efficiency it is the store and the power house. The power house requires stores not even semi-occasionally, while the storehouse needs power only for lighting and possibly elevators, and only a small amount of steam for heating. Such examples can be multiplied indefinitely.

In general, every repair shop may be considered as having three departments—locomotive, coach and freight car. There is also, in every case, a power house, a storehouse, a blacksmith shop, a planing mill; and, in some cases, a wheel shop and also an iron foundry. For the purpose of citing the most obvious of the rules affecting the arrangement of buildings, the main departments will each be considered with relation to the various sub-departments, namely, the blacksmith shop, machine shop, planing mill, power house, and storehouse.

Taking up, first, the freight car department, it is, in most cases, a repair department only; and even is very likely to be composed merely of repair tracks for bad order cars. The number of cars handled, however, makes it an important consideration. As it is probable that fifty cars are switched onto the rip-tracks for every locomotive set into the erecting shop, it is safe to say that the freight car department should be placed adjacent to the main line, even at the expense of the locomotives and coaches. By reducing the length of switching movements, considerable time, trouble and even confusion, can be avoided.

Blacksmith shop work for this department is of evident importance. A vast amount of small blacksmith work has to be done for the car repairers, and this should make it imperative that the blacksmith shop be near; in fact, adjacent to the repair tracks, unless one is sufficiently reactionary to duplicate facilities.

Machine work for the department, excepting wheels, is not large in amount and is, in any event, rough. If a separate wheel shop building is put up, it is safe to say that it must be adjacent to the repair tracks, but in a plant too small to warrant a separate wheel shop building, and requiring machine work to be done in the locomotive machine shop, it is not necessarily axiomatic that the machine shop be adjacent to the repair tracks. Mounted wheels with good industrial track facilities are quite easily transported.

Planing mill work for the freight car department is, of course, of absolutely primary importance. In a shop so large as to permit passing lumber through the planing mill in large lots to be held till needed in the finished lumber store, the necessity for locating the mill adjacent to the rip-tracks is not so much in evidence. However, in any event the finished lumber store must be convenient to the repair tracks, preferably adjacent to the freight car repair shop building, where one exists, on account of the greater probability of heavy work being there, rather than on the repair tracks.

The power house is manifestly an unimportant factor of the department. No power except air is used, and no steam for heating the repair tracks is necessary.

Stores for the department are not widely diverse in character and sub-stores seem to be the rule at present. However, the quantity of material going from the storehouse to the department, especially to the freight car shop, is very large, and for all purchased material at least, if the storehouse is not adjacent to the freight car department, it necessitates double handling and, in fact, unnecessary duplication of facilities all around. It is safe to say, therefore, that the storehouse should be adjacent to the freight car shop and as convenient as possible to the entire length of repair tracks.

The coach department is of necessity a rather minor one. The number of coaches on the average road is relatively small, and this, combined with the class of work done on the coaches while in the shop, reduces the importance of the department in regard to its relative location.

Blacksmith work is required in a fair amount, and consequently the blacksmith shop should, if permissible for a minor department, be located near the coach repair shop.

Machine work, excepting wheels, is required only in small amount. Tire work is, of course, very heavy relatively. If a separate wheel shop building is considered it should be adjacent to the coach shop, but the same argument applies here regarding wheels as in the case of the freight department.

Planing mill work, and especially cabinet shop work, is of vital importance, although the quantity of material is smaller than in the case of the freight car shop, and a positive rule can be safely made that the planing mill and coach shop should be adjacent.

Stores for the department are generally small in quantity and and practically all castings have to be machined. Where manufacturing is done this necessity is even greater on account of the double movement between the two buildings.

Power is important and the power house should be adjacent to the locomotive shop, not only on account of the amount of power used, but also on account of the desirability of reducing the length of the pipe tunnel for live and exhaust steam and air piping between the two buildings.

The relations of the three main departments with each other are, as before mentioned, unimportant, except in the cases where the wheel shop machinery is located in the locomotive machine shop.

Of the sub-departments not covered by the foregoing, the power house may be said to necessarily be near to the locomotive shop, the blacksmith shop and the round house on account of the very large amounts of steam required in these buildings. It should also be within 250 feet, or preferably 200 feet, of the planing mill, on account of the high cost and mechanical difficulty of blowing shavings from the mill to the power house boilers when the distance is great. The coach shop, freight car shop, wheel shop, storehouse and foundry need but little steam and need not be near the power house.

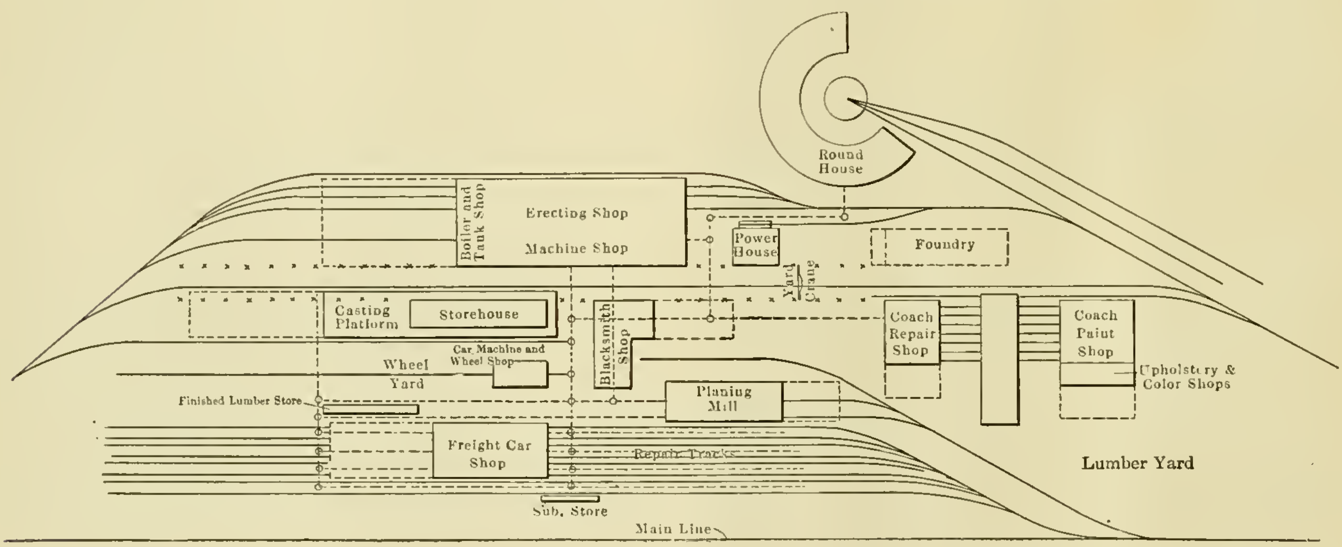


FIG. 1.

need not be considered of great importance. Power is also practically negligible.

This brings the matter up to the consideration of the locomotive department. In this there is a very strong and decided tendency toward having the erecting, machine and boiler shops in one building. This practice is backed by the very sound reason that boilers of to-day absolutely require crane service, and by extending the erecting shop this service can be obtained from cranes which have to be furnished for the erecting shop in any case. The small extra cost of having the boiler shop and machine shop of the same height is more than balanced by the advantage of being able to take boilers off their frames and set them in the boiler shop, without putting them on trucks or even changing hitches. Tank work is necessarily done in the boiler shop on account of similarity of labor.

Blacksmith shop work for the locomotive department is, of course, of more importance than is found in any other department relation. Manifestly the blacksmith shop must be adjacent to the machine or erecting shop, preferably the former, as the distance of transportation of material is somewhat less, and the convenience greater.

The machine shop is, in every case, a part of the main locomotive shop.

Planing mill work is so small in quantity and is decreasing so steadily as to be negligible.

The storehouse must necessarily be adjacent to the machine shop, as the casting platform is usually a part of the storehouse

The planing mill need be near only the freight car shop, adjacent to the coach shop and repair tracks and within 250 feet of the power house. At one end of the mill should be space for storage of a large amount of rough lumber, and at the other end should be the finished lumber store, so that lumber can go through the mill without any retrograde movements even outside. The dry kiln, when installed, must, of course, be between the lumber yard and the planing mill.

The round house, whether a small one used only for breaking in engines, or a large one for regular terminal work, should, if possible, be near the power house, as before stated. It should also be near the machine and blacksmith shops, on account of the considerable amount of these classes of work often done for the round house. The approach tracks should be long and straight to permit easy storage and movement of engines under steam, and also to give ample room for coal and ash handling facilities.

The wheel shop, when installed, should be adjacent to all three main departments. This is probably an impossible condition and the freight car department takes precedence over the coach shop and locomotive departments. This would give a location adjacent to the freight car shop.

The iron foundry is strictly a manufacturing shop with a given daily output which can be handled in large lots on trucks. This permits its location at any point in the shop yard where ample room can be left around it for the storage of flasks, coke and iron.

Yard cranes, when installed, should serve as many buildings as possible. A saving will also be effected by supporting the crane runway on building walls rather than providing separate steel columns, and this would make it advisable to locate the crane over the longest passageway between buildings which exists in the shop layout.

The proper distance between buildings which avoids bad fire risks cannot be definitely fixed. However, experience has shown that seventy-five feet is the practical minimum, and under no circumstances should main buildings be placed less than fifty feet apart.

Naturally in the foregoing list of desirable conditions there are several which are contradictory. It is, for instance, a probable impossibility to locate both the storehouse and blacksmith shop adjacent to all three of the main departments. The necessity for providing space for extension of all buildings also involves conditions which increase the difficulty of finding an entirely satisfactory arrangement. In consequence it is certain that arrangements will always vary in accordance with individual ideas as to which departments should be favored. Figures 1 and 2 show arrangements embodying most of the desired conditions. The two are exactly the same scheme, except that Figure 1 shows a longitudinal erecting shop and a transverse coach shop, while Figure 2 shows a transverse, lift over, erecting shop and a longitudinal coach shop, the latter being possibly more desirable for very small shops.

Machine shop adjacent to storehouse, blacksmith shop and power house, also to round house, when possible.

Power house adjacent to blacksmith shop, machine shop and round house, and not over 250 feet from the planing mill.

In conclusion, the question may arise as to how much ground area is required for the proper construction of a complete set of shops. This may be very roughly determined by using a figure of from 2 to 3 acres per pit in the erecting shop. These figures are based on existing arrangements, the former requiring a decidedly compact arrangement of buildings. It is, of course, a practical impossibility to have too much ground for a shop, especially in view of the future extensions, which are absolutely certain to eventually become necessary.

CONVENTION OF THE TRAVELING ENGINEERS' ASSOCIATION.

The Eighteenth Annual Convention of the Traveling Engineers' Association will be held at the Clifton Hotel, Niagara Falls, Canada, commencing at 10 A. M., Aug. 16, 1910, and continuing four days.

Following is list of subjects to be discussed at this meeting:

1.—Fuel economy, under the following heads:

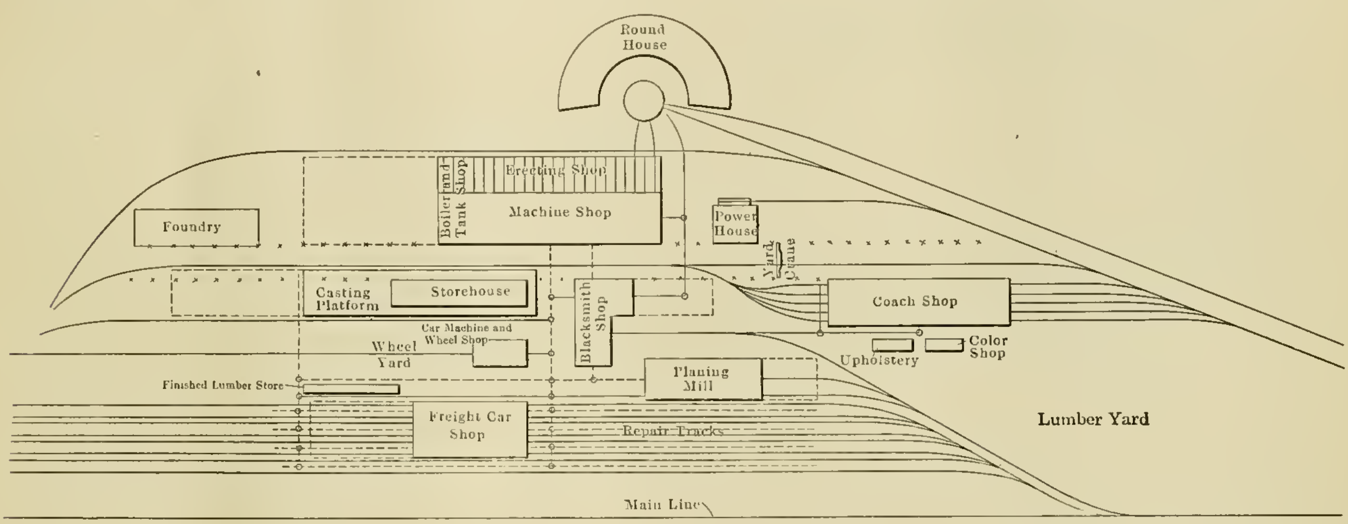


FIG. 2.

The most evident weak feature of these layouts lies in the distance of the coach shop from the wheel shop. The fact that the wheel shop is not on the line of the yard crane is another undesirable feature, provided, of course, that a yard crane is installed. These are both the outcome of favoring the most important department.

Summed up, it may be said that the following considerations govern any shop arrangement, provided ground area is not restricted, or the track system prearranged:

Freight repair tracks and freight car shop near to main line.

Finished lumber store adjacent to freight car shop.

Planing mill between lumber yard and finished lumber store and adjacent to repair tracks.

Coach repair shop adjacent to planing mill and near wheel shop.

Storehouse adjacent to freight car shop and to machine shop.

Blacksmith shop adjacent to freight car shop and machine shop, also adjacent to car-machine and wheel shop when one is installed.

Wheel shop adjacent to all departments, but especially to the freight car shop.

(a) Value of present draft appliances. Can they be improved to effect fuel economy?
(b) Firing practices, including the prevention of black smoke.
(c) Roundhouse practices; whether it is more economical to knock or bank fires at terminals.
(d) Whether it is more economical to buy a cheap fuel of a low heat value, or a higher priced fuel of a greater heat value.
(e) Devices and appliances for use on engines and tenders to prevent waste en route.

2.—Superheat as applied to locomotives.

3.—How can the traveling engineer best educate the present day fireman to become the successful engineer of the future?

4.—Latest developments in air brake equipment and its effect on train handling.

5.—What progress has been made in reducing the cost of locomotive lubrication, and is it advisable to place this item entirely under the control of the road foreman or traveling engineer?

6.—New valve gears as compared with Stephenson or link motion, referring particularly to economy of operation and maintenance, and also necessary procedure in case of breakdowns.

APPRENTICE SCHOOL.—We inaugurated an apprentice school on our road about six months ago. When it was first suggested some of the men said we did not have the facilities, but we made them. We took two box cars, put them together, and put windows in them, and you would be surprised at the results we are getting from the apprentice boys that started in the school six months ago. They are all students. There should be more students among the mechanical men.—*F. C. Pickard at the General Foremen's Convention.*

CANADIAN PACIFIC RAILWAY.
MOTIVE POWER DRAWING OFFICE.

RECORD OF TEST NO. 50 ON Piston Rod Lubricator

Applied to engine 1191 . Eastern Division, Oct 10 1909 ; Reports expected every two weeks

" " 866 . " Division, " 30 1909 ; Reports expected " " "

" " ______ . ______ " ______ 19 ______ ; Reports expected ______

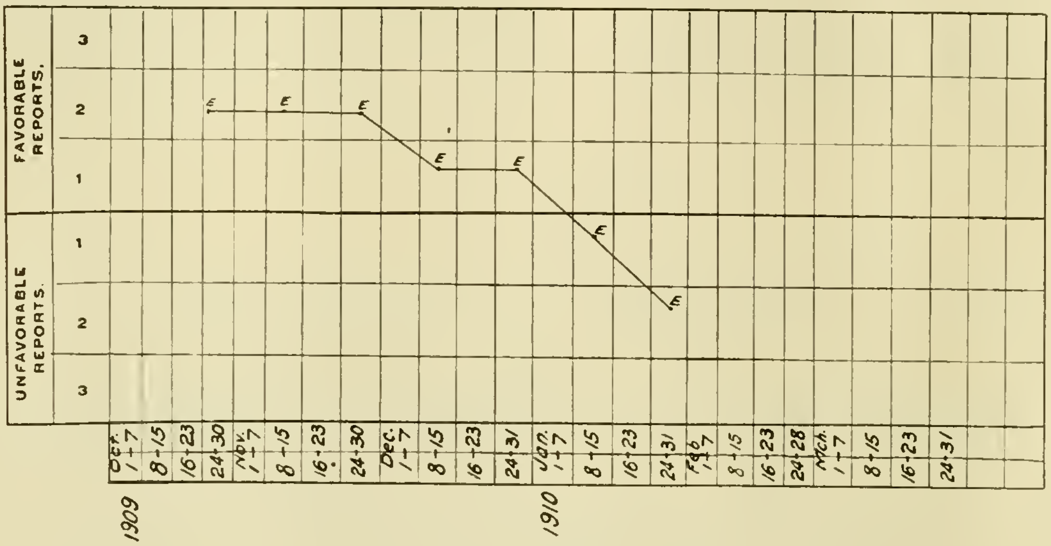
" " ______ . ______ " ______ 19 ______ ; Reports expected ______

" " ______ . ______ " ______ 19 ______ ; Reports expected ______

" " ______ . ______ " ______ 19 ______ ; Reports expected ______

Authority for test Supt. Motive Power, letter Oct. 1st 1909 Final report to be sent to Asst. to Vice President & Supt. Motive Power

Remarks as to application This lubricator is intended to oil the piston rods and works as a displacement lubricator when throttle is open, and as a syphon oil cup when throttle is closed. It must be shut off when engine is standing.



FACE OF CARD FOR KEEPING A GRAPHICAL RECORD OF ROAD TESTS.

SUMMARY OF REPORTS.

Oct 25th lubricator on 1191 oiling rod satisfactorily, engineer reports more satisfactory than swabs

Nov. 12th lubricators on 1191 & 866 satisfactory, same condition as previous reports

" 27th " " " " " " " " " "

Dec. 12th considerable oil being used

" 28th " " " "

Jan 10th entirely too much oil being used, when engine is drifting and cup is working as syphon all oil is drawn out in a short distance

Jan 28th lubricator becomes inoperative in cold weather owing to fine feed which is necessary

RECOMMENDATIONS.

TEST CLOSED Feb 1. 1910 RESULT Owing to construction of lubricator it was difficult to apply to existing cylinder heads, it used excessive amounts of oil and froze up in cold weather.

Papers filed in Test Fyle, T50.

REVERSE OF CARD FOR KEEPING A GRAPHICAL RECORD OF ROAD TESTS.

A GRAPHICAL RECORD FOR ROAD TESTS.

G. I. EVANS.

A great many railroads, from time to time, test some of the numerous devices put on the market for use on locomotives and cars. Such devices are generally not amenable to laboratory tests, and must be put into actual service before any idea can be obtained as to their usefulness, and, as one or more may be applied on different locomotives running on different divisions of a railroad, and may be in service any length of time from one to twelve months or more, and, as results are noted and reported by master mechanics and other operating officials, considerable correspondence accumulates before any definite conclusions may be arrived at.

Given a sufficient number of such tests, a man will spend much more of his time than he can spare in wading through files of correspondence, trying to get an idea how matters stand, and having just this condition, the writer, some time ago, devised the combined record and chart which is shown in the illustration as a convenient way for following up road tests. The record is kept on letter size cards (8⅛ in. by 10¼ in.) outlined as shown, and are printed on both sides. These cards are filed apart from the correspondence, consecutively, in a vertical file, and as they take up but small space, a large number can be retained in the file, forming a permanent record of all tests made. The correspondence file, which is bulky, is regularly weeded out and all closed tests are removed to the storage file.

The first portion of the card gives a complete record of the application of the device, when reports are to be sent in, and to whom the final report is to be submitted, while the chart shows at a glance how these instructions are being carried out, and what results are being obtained.

The chart is divided into two main horizontal sections, the one above the heavy line is for reports favorable to the device under test and the lower for those unfavorable; each of these main divisions is again subdivided into three sections, each of which represents a degree of excellence or unsuitableness as compared with some standard which has been previously assumed, thus, a report may be received saying that a certain device is giving as satisfactory service as the one which it is intended to supersede. This would naturally be a No. 1 favorable, but if the report had shown that the performance was slightly better than the standard, it would be a No. 2 favorable, etc. Unfavorable reports are recorded in a similar manner, slightly inferior to the standard constituting a No. 1 unfavorable, etc. When entering the report a dot is made opposite the month in such a position as to represent approximately the date received and the curve is drawn through these points, a letter representing the division is placed close to the dot showing from where the report came. By noticing whether the dates on which the reports are received correspond with the dates on which they are expected, a check can be kept on who is behind with reports.

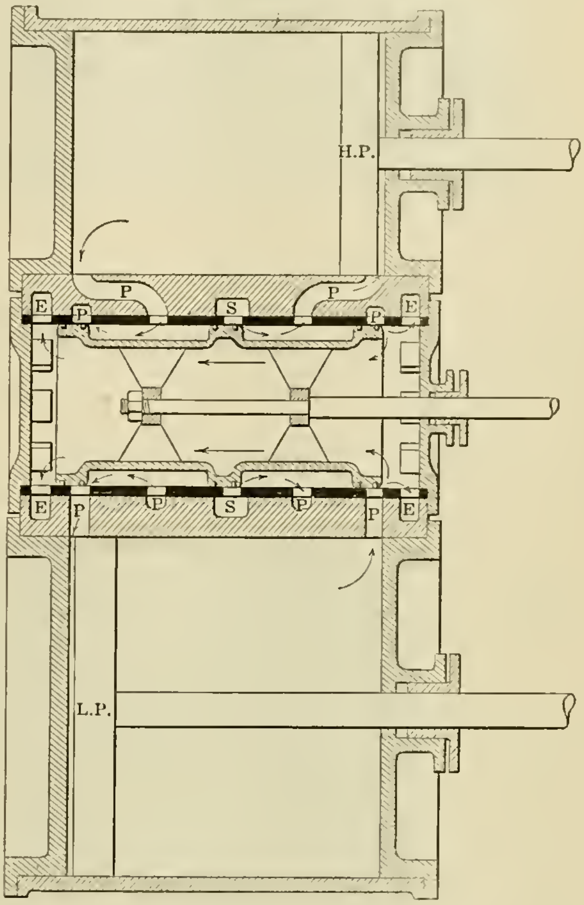
On the back of the card is a short summary of each report received, and finally the date on which the test was closed and the recommendations made as to the advisability of adopting the device.

PISTON VALVE FOR BALANCE COMPOUND LOCOMOTIVE.

M. W. DAVIDSON.

The accompanying illustration shows a proposed design of piston valve for balanced compound locomotives worked out by the writer, which appears to possess some points of advantage over other types of this valve with which he is familiar.

The sketch is not drawn to represent an actual design of this valve, but merely to show in general its construction and operation. The cavity surrounding the valve and marked S contains live steam from the boiler, the two marked E, one at each end, being the exhaust ports to the atmosphere, those marked P are the ports to the cylinders, as may be clearly seen. In the dead center position shown, the high pressure piston is receiving steam on the crank side while the steam from the opposite side of that piston is exhausting into the low-pressure cylinder, head end, also the steam from the crank end of the low pressure cylinder is exhausting into the atmosphere through both exhaust passages E, if the valve is made hollow, as is shown in the illustration.



At first glance, objection might be made to this valve on account of the clearance it gives to the high-pressure cylinder; however, the incoming steam to this cylinder always finds this space full of steam compressed almost to boiler pressure; also, this clearance volume, which is really a part of the passage to the low pressure cylinder, being full of steam when the valve opens to the low pressure piston, the drop in pressure between the high and low pressure cylinders is small.

This valve also possesses the advantage of simplicity of construction and few parts, only six rings being required, as against twelve on one well known valve designed for similar use. The steam and exhaust cavities are much simplified as well.

COMBINATION BUFFET AND BAGGAGE CAR.

There was recently turned out of the West Albany shops of the New York Central & Hudson River Railroad, combination baggage and buffet car No. 473, which as is evident from the accompanying view of the interior and floor plan, is most attractively finished and conveniently arranged. The car has a length of 70 ft. over end sills, the baggage compartment occupying 22 ft. 1½ in. at one end and the passenger compartment 35 ft. 2 in. of the other end, between these being located the pantry and barber shop.

In the passenger compartment there are 18 movable mahogany chairs beautifully upholstered in green leather and two Pullman seats, giving a seating capacity of 26 passengers. The arrangement includes a bath room, very ingeniously located so as to occupy the minimum of useful space. It contains a shower bath and is entered from the barber shop. The barber shop section is much larger than customary, and has light from both sides

COMBINATION BAGGAGE AND BUFFET CAR—NEW YORK CENTRAL LINES.

of the car. The barber shop, bath room and pantry combined occupy but 12 ft. and each is amply large. The arrangement of the toilet room at the end of the car has also been very ingeniously worked out to give maximum facility in a minimum room.

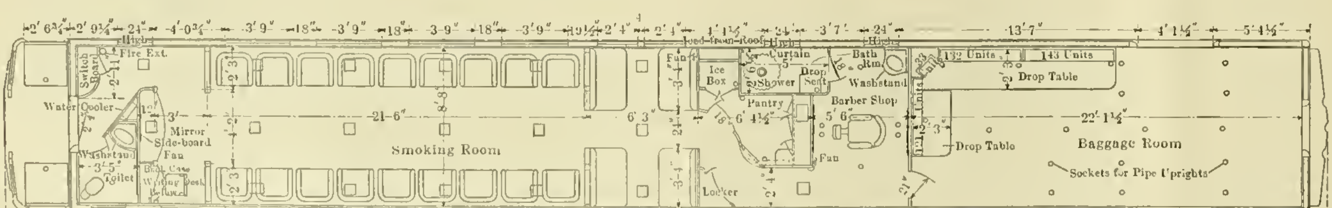
The square, beamed ceiling fitted with concealed lights in attractive fixtures, is used in the smoking compartment. The finish is severely plain so far as the woodwork is concerned but is relieved of all monotony by the lighting fixtures underneath the deck and the art glass ventilators. The seats are of heavy polished mahogany design that is in keeping with the interior finish of the car, which is also of polished mahogany. Electric lights are of course used throughout the car, and several fans are also provided. Current is obtained from a 60-volt Gould battery. The total number of lights in the car is 43.

In the baggage compartment are cases for distributing mail to the number of 429, with convenient tables which can be dropped down out of the way when not in use. The underframe is of steel throughout and the car is carried on standard 6-wheel wooden trucks.

Among the specialties are the following: Miner spring draft rigging; Westinghouse type L brakes; Waycott brake beams; Commonwealth steel platforms; Tower coupler; Ward vapor steam heat; Garland ventilators; Chaffee centering device; Edwards window fixtures and steel trap doors; and Taylor oil boxes.

This car has a total weight of 136,700 lbs. and measures 75 ft. 6 in. in length over all. The journals are 5 x 9 M. C. B. standard

VIEW SHOWING THE HANDSOME INTERIOR OF THE SMOKING ROOM.



FLOOR PLAN OF COMBINATION CAR—NEW YORK CENTRAL LINES.

VERY POWERFUL ARTICULATED COMPOUND LOCOMOTIVE

A GENERAL DESCRIPTION OF A DESIGN FROM WHICH THE AMERICAN LOCOMOTIVE COMPANY HAS BUILT SIX LOCOMOTIVES FOR THE DELAWARE & HUDSON COMPANY TO OPERATE ON A GRADE BETWEEN CARBONDALE AND ARARAT, PA., WHERE THE RULING GRADE IS 1.36 PER CENT. AND CURVES ARE NUMEROUS.

Out of Carbondale, Pa., northward, the Delaware & Hudson Company operate a large number of solid coal trains that normally have a tonnage of about 2,600. Between this point and Forest City there is a continuous grade of 1.36 per cent., then follows a grade of .81 per cent. for the next 14 miles, ending at Ararat. This is the summit of the rise, and from here into Oneonta, N. Y., is a down grade of averaging 1 per cent. for the 75 miles. The loaded traffic is practically all north bound and a 2,600 ton train is placed behind a class E-5 consolidation locomotive,* which will handle it very satisfactorily on the down grade from Ararat to Oneonta, but from Carbondale to Ararat it is necessary to put two locomotives of the same class behind the train as pushers. With this motive power a speed of ten miles per hour can be maintained for the first six miles and of 15 miles per hour for the next 14. The class E-5 locomotives have a total weight of 246,500 lbs., of which 217,500 is on drivers. The tractive effort is 49,690, the cylinders being 23 by 30 in.; drivers, 57 in., and steam pressure, 210 lbs.

It is evident that this section of the road is of a character particularly well suited for the Mallet Articulated compound type of locomotive and with the idea of determining what advantages that type possessed under these conditions, the Delaware & Hudson Company borrowed from the Erie Railroad one of its Mallet locomotives and made a number of test runs. The Erie engine easily did the work of the two class E-5 pushers and the result of the test was the placing of an order with the American Locomotive Company for six engines of the design illustrated herewith.

This design, while considerably larger than the Erie engines, is but slightly modified from that arrangement or from the other articulated locomotives built by this company in smaller sizes. The wheel arrangement is of the 0-8-8-0 type and is arranged to give about ten per cent. more power than the Erie engine, the weight being increased about 35,000 lbs. over that arrangement. In working order they have a total weight of 445,000 pounds, all of which is carried on the driving wheels. The high pressure cylinders are 26 in. in diameter by 28 in. stroke, and the low pressure cylinders are 41 in. in diameter by the same stroke. With the boiler pressure of 220 pounds and driving wheels 51 in. in diameter, the theoretical maximum tractive effort, working compound, is 105,000 pounds. With the Mellin system of compounding employed, the normal maximum tractive effort working compound can be increased about 20 per cent. by changing the engine into simple. The maximum tractive effort of these engines working simple is thus 126,000 pounds.

With the same average weight per driving axle and a rigid wheel base 2 feet 3 inches shorter, these articulated locomotives, thus, under normal working conditions, have over twice the power of the Class E-5 consolidation locomotives, and in case of emergency can exert a tractive effort more than two and one-half times as great as the latter.

One of these engines as a pusher and a Class E-5 locomotive in the lead, will easily take a 2,600 ton train up the grade, where it previously took three Class E-5 locomotives. The six articulated locomotives in this order will, therefore, relieve 12 of the consolidations from this service without sacrificing any tonnage, and with a saving in operating expenses due to handling less units.

Apart from the increase in size and power, the principal changes in the design from that of the Erie engines† are a different arrangement of high pressure steam pipes, and the location of the cab over the fire box.

Owing to the large diameter of the boiler, it was necessary in this instance to locate the high pressure steam pipes underneath the running boards, as shown in the illustration of the side elevation. Steam is led from the throttle through a dry pipe to the smoke box, where it is divided in a tee-head and passes into two branch pipes, one in either side of the smoke box, in the same manner as in a single expansion engine. From these branch pipes, to which they are connected through elbows with ball joints, two wrought iron steam pipes extend back underneath the running board, on either side of the boiler, to the high pressure cylinders. An elbow covers the steam passage to the cylinders, to which the steam pipe is joined by means of a specially designed connection having a ball joint at either end and fitted with a slip joint. This construction permits of the expansion and contraction of the steam pipe, due to variations in temperature, and also facilitates removing and putting it up when repairs are necessary.

With this arrangement of steam pipes, the engineman is afforded a comparatively unobstructed view ahead.

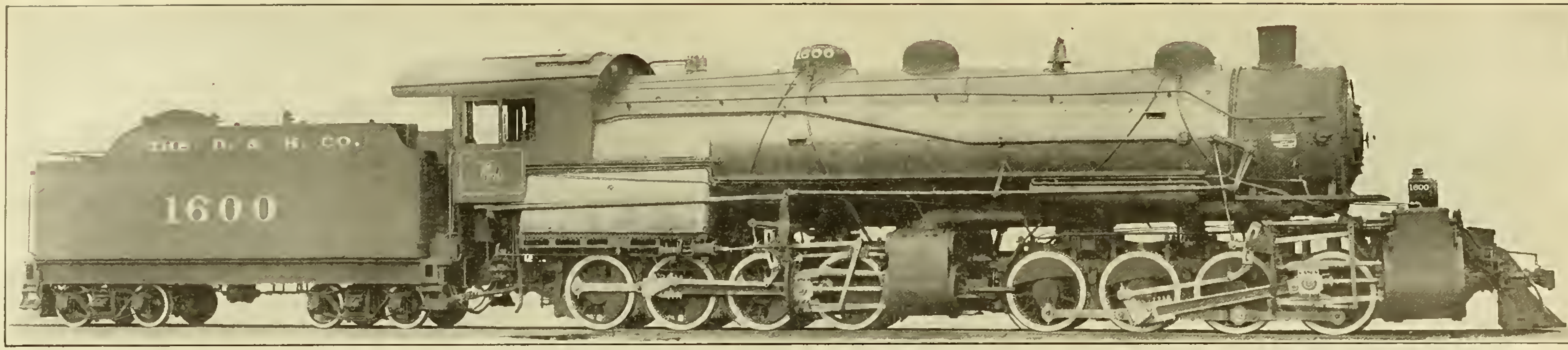
The design of the cylinders is, in general, the same as used on previous Mallets built by the same company. The low pressure cylinders are the largest in diameter ever applied to a locomotive, being 41 in. by 28 in. Steam is distributed to the high pressure cylinders by 14 in. piston valves having inside admission and ample port area to meet the requirements. The low pressure cylinders are equipped with Mellin double ported balanced slide valves which have been used successfully on previous articulated locomotives. Special provision has been made for strengthening the valve yoke. This is stayed by two longitudinal bolts passing through cored passages in the valve. The bolts are one inch in diameter and fitted with one inch wrought iron pipe thimbles, which act as spacers.

The valve gear is of the Walschaert type and is reversed by a hydro-pneumatic reversing gear. A slight modification from the arrangement of this gear as applied to previous engines of the articulated type has been made. This consists first in connecting the piston rod of the reversing engine to a downward extension of the arm on the main reverse shaft, instead of to the main reverse lever itself. Also, the handle of the main reverse lever which ordinarily projects above the deck of the cab is in this instance cut off, thus providing more room in the cab. A separate handle for the main reverse lever is provided, which can be easily applied in case it is necessary to operate the lever by hand in case of an accident to the power gear.

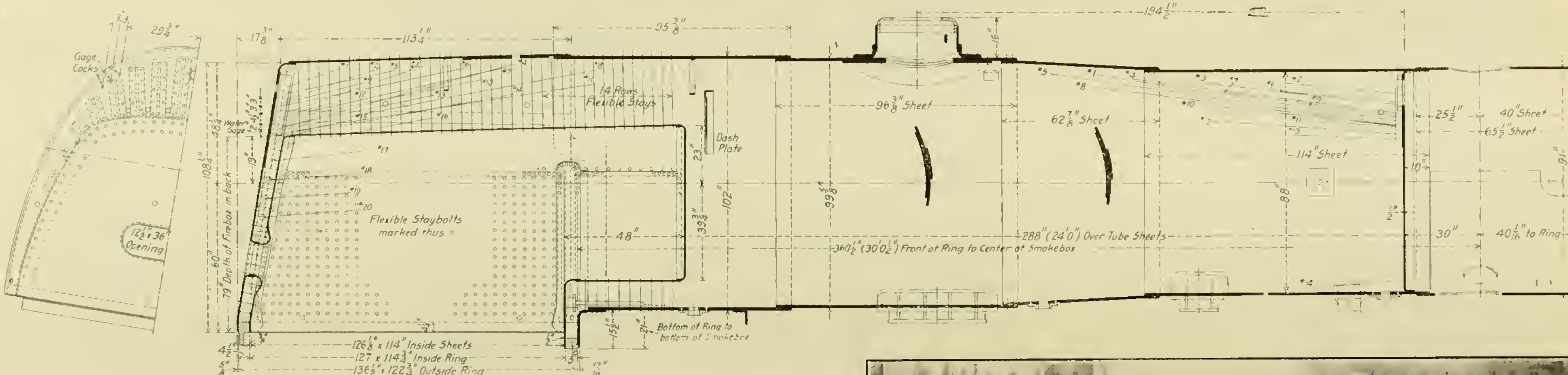
The frames throughout are of vanadium cast steel and of large section. The frames of the rear engines have a single front rail cast integral with the main frame, while those of the front system are provided with double front rails, the lower one of which is in one casting with the main frame. Both sets of frames are 5½ in. in width throughout, except that portion of the lower front rails of the front set which is underneath the cylinders. This portion is reduced to 3¼ in. in width, and reinforced by an auxiliary rail 4 in. wide, bolted to the inside of the lower rail and extending the full length of the cylinders. Over the pedestals, the upper rails of the main frames are 6½ in. deep, while between pedestals the depth of section is 5 in.,

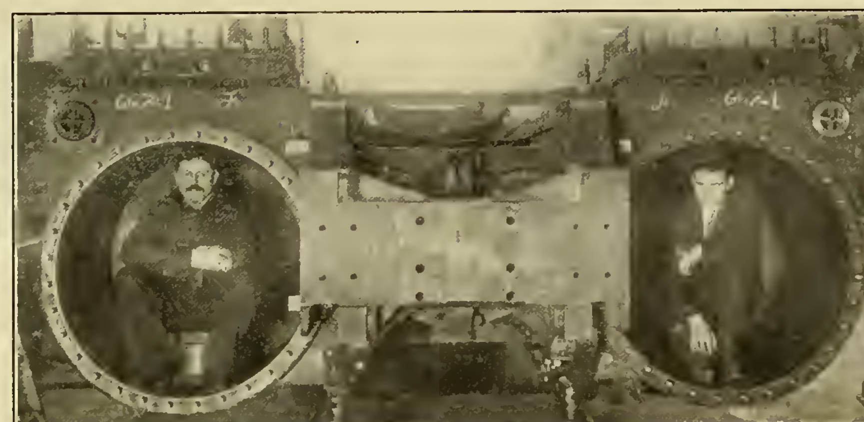
* See American Engineer, January, 1907, page 22.

† See American Engineer, Sept., 1907, page 338.



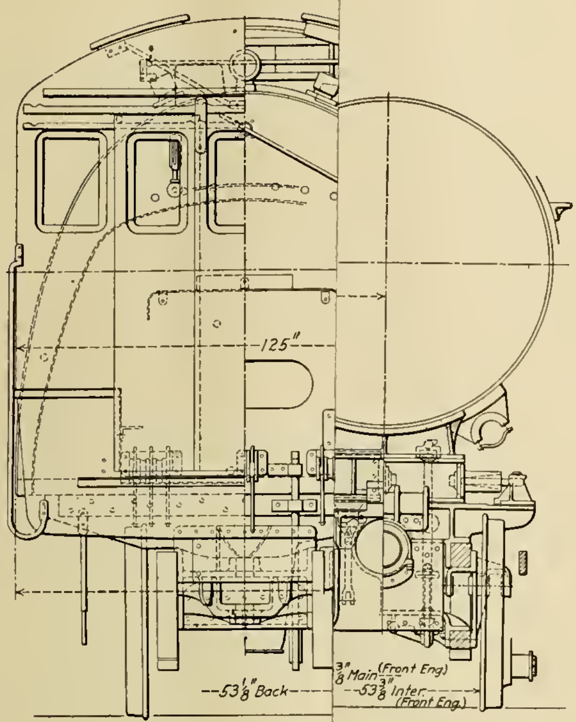
0-8-8-0 TYPE LOCOMOTIVE FOR THE D. & H. CO. THIS LOCOMOTIVE HAS 24-FT. TUBES AND A MAXIMUM TRACTIVE EFFORT OF 126,000 LBS.

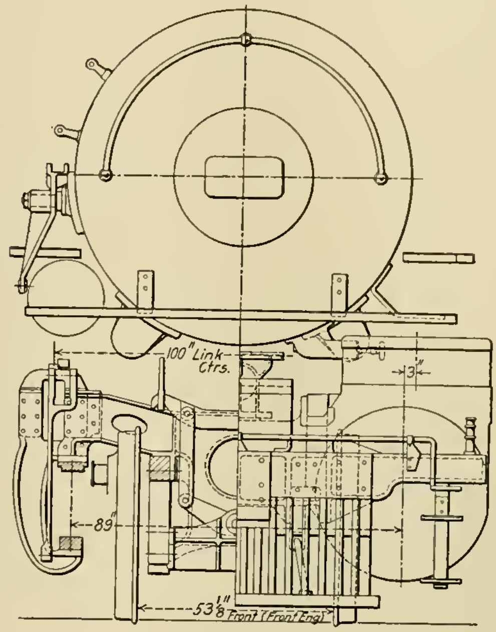


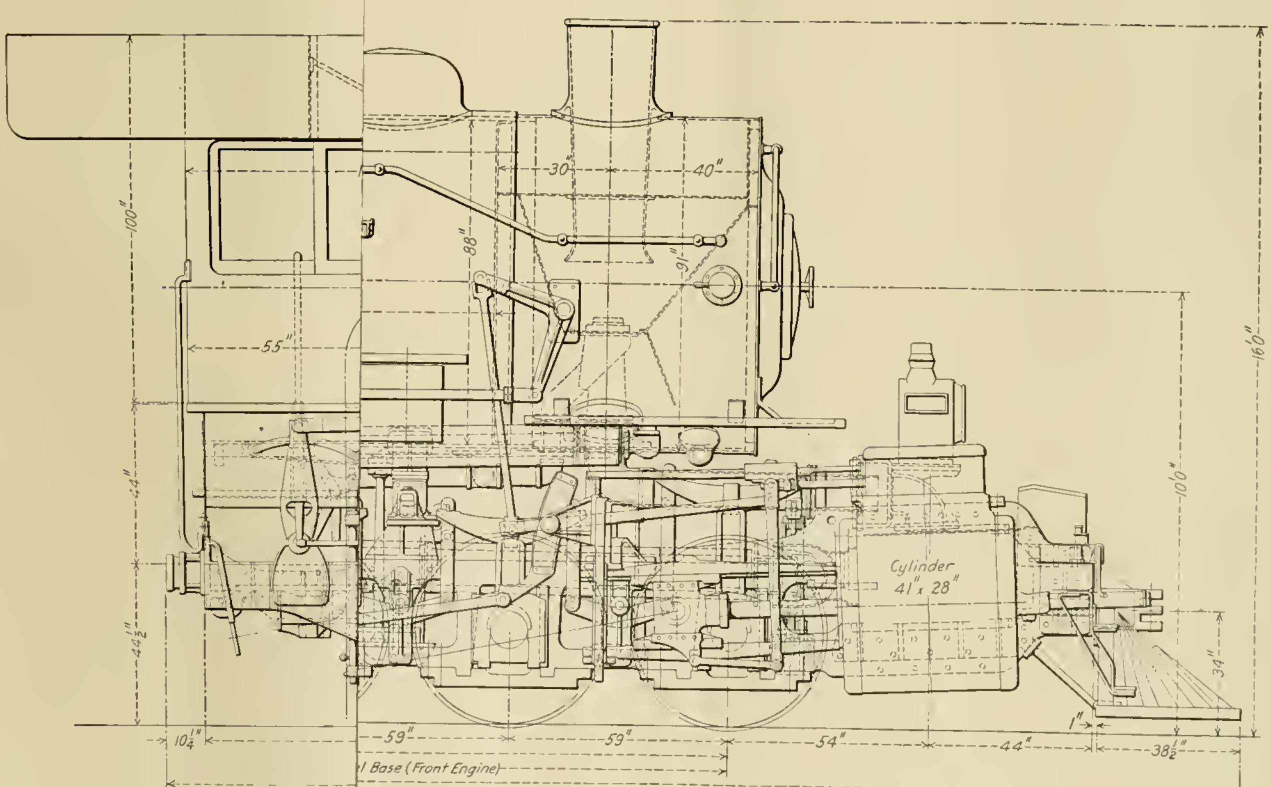


SECTIONAL ELEVATION AND VIEW OF THE VERY LARGE BOILER APPLIED TO THE ABOVE LOCOMOTIVE; ALSO VIEW OF THE 41-INCH LOW-PRESSURE CYLINDERS.

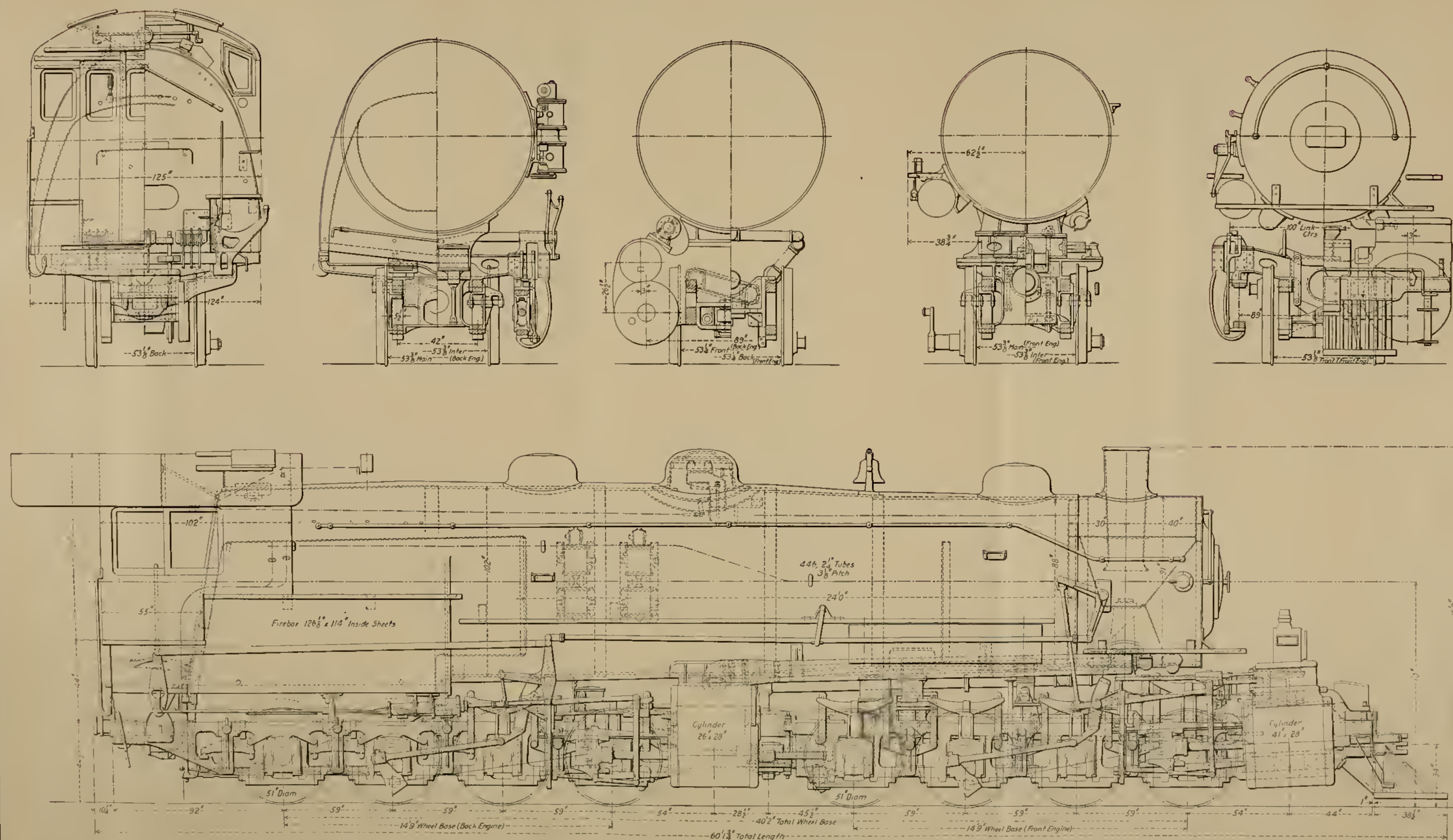
From the AMERICAN ENGIN



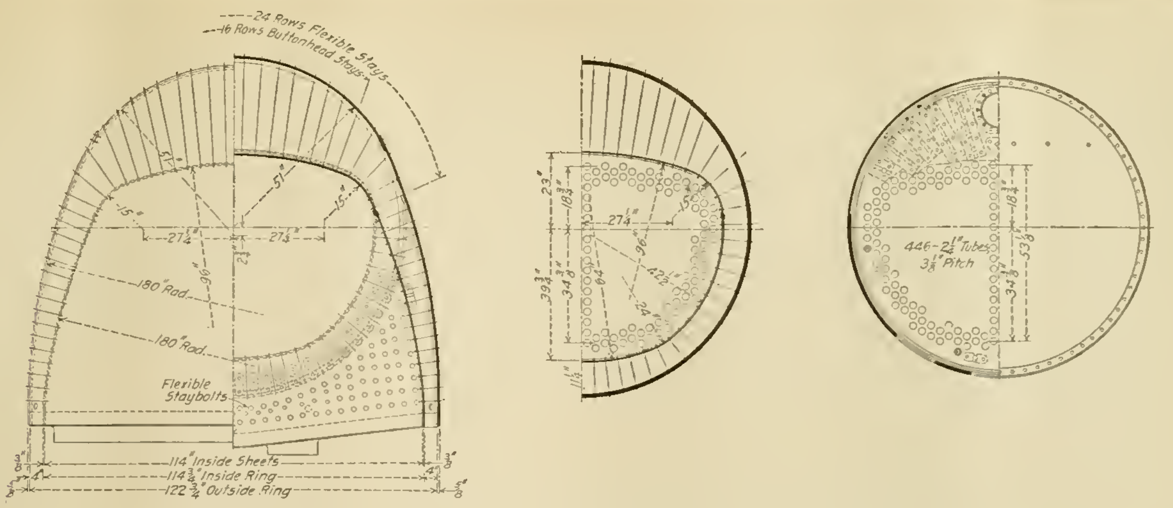




PANY BY THE AMERICAN LOCOMOTIVE COMPANY.



MALLET ARTICULATED LOCOMOTIVE, 0-8-8-0 TYPE, HAVING A MAXIMUM TRACTIVE EFFORT OF 126,000 POUNDS, BUILT FOR THE DELAWARE AND HUDSON COMPANY BY THE AMERICAN LOCOMOTIVE COMPANY.



SECTIONS OF THE VERY LARGE BOILER ON THE DELAWARE AND HUDSON MALLET.

except at those points where the equalizing beam fulcrum castings are introduced. The bottom rails of the frames are in the main 4¾ in. deep.

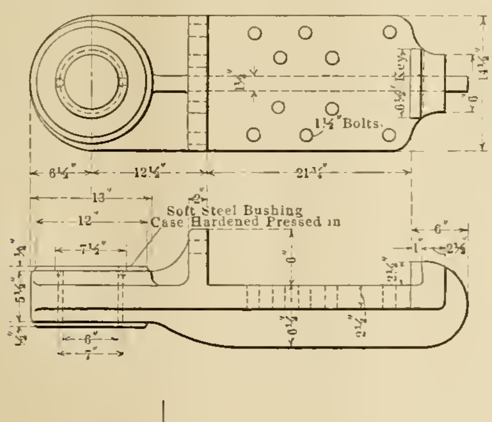
A single articulated connection is used between the front and rear systems. This is formed by a cast steel radius arm rigidly bolted to a cast steel crosstie between the rear ends of the front frames. This radius arm fits in a steel pocket casting securely bolted to the bottom rails of the rear frames, and also extends back underneath the high pressure cylinder saddle, to which it is bolted. The coupling is made by means of a vertical pin 6 in. in diameter, inserted from the top.

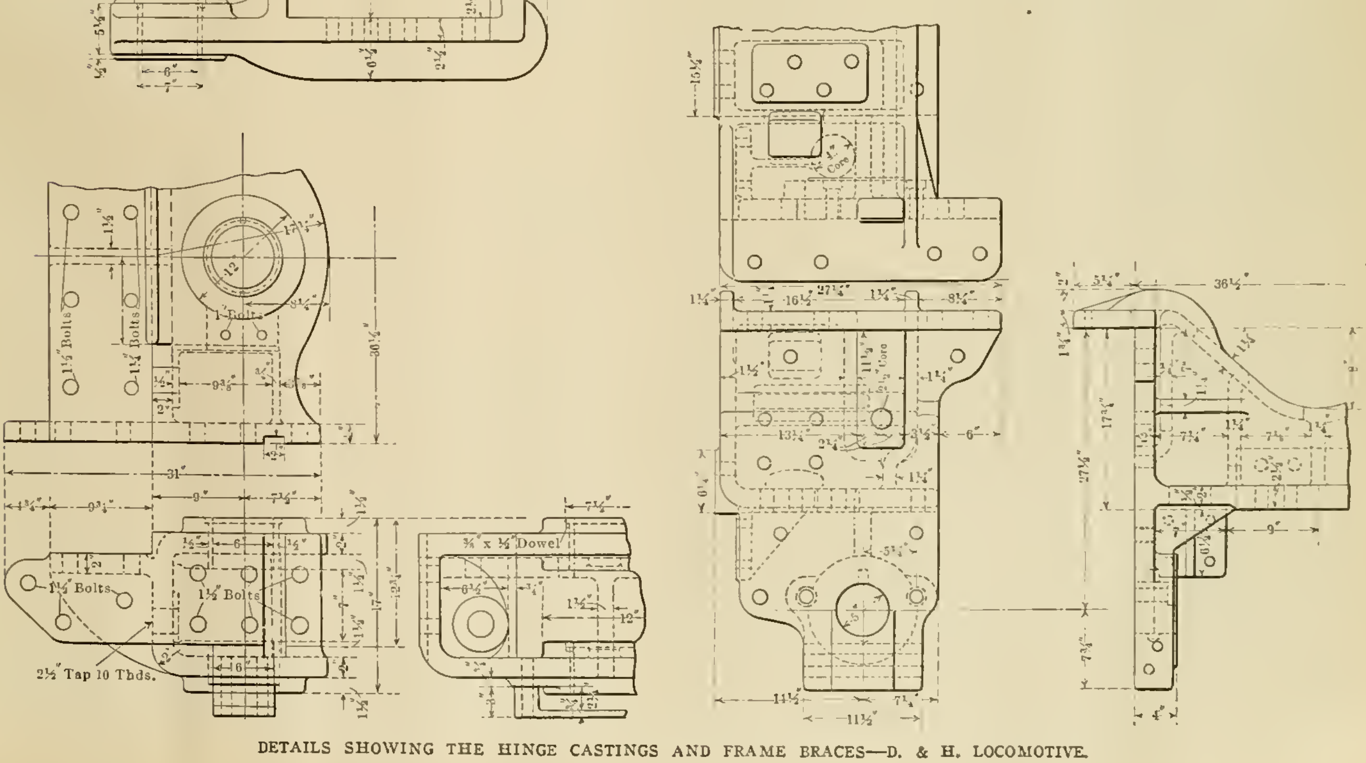
This gives a very strong and substantial connection between the two engines, and at the same time the use of the single articulated connection permits of the vertical movement of the two frames relative to each other, without any binding in the joint.

An exceptionally strong and substantial system of frame bracing is employed. In the front and back systems there are in all 16 cross braces between the frames, taking into consideration the high and low pressure cylinder castings. All the cross ties are of cast steel and of such a construction as to provide the maximum of strength with the minimum weight. With but one or two exceptions, the several crossties extend down to the bottom rails of the frames and are secured to the frames by both horizontal and vertical bolts. The location and arrangement of the cross braces are shown in the illustrations of the side elevation and cross section on the accompanying insert.

Two features which have proved very successful in the articulated locomotives built for the Erie Railroad have been incorporated in this design. These are the floating balance device and the side spring buffers at the frame union.

The floating balance device is located between the second and third pair of drivers of the front system immediately back of the boiler bearing which carries the spring centering device and consists of a pair of spring supported columns. These have ball and socket connection at their upper ends with the saddle cast-





DETAILS SHOWING THE HINGE CASTINGS AND FRAME BRACES—D. & H. LOCOMOTIVE.

ing of the boiler bearing to a similar connection at their lower ends with two castings hinged at one end to the bottom of the cast steel crosstie between the lower rails of the frames. The outer ends of these hinged castings rest in "U" bolts and are supported by coil springs seated on the crosstie. These columns serve to support the portion of the weight which would otherwise come on the main boiler bearing, thus relieving that bearing of excessive pressure. In this instance, the total initial compression of the springs is about 30,000 lbs. With this arrangement, that part of the weight of the boiler carried by the front system is divided up between three supports. The surfaces of the boiler bearing, located between the second and third pair of driving wheels are normally not in contact, so that this bearing does not support any weight except under unusual conditions. With this construction the columns are free to sway in any direction, while they support a load equal to the total compression of the four springs.

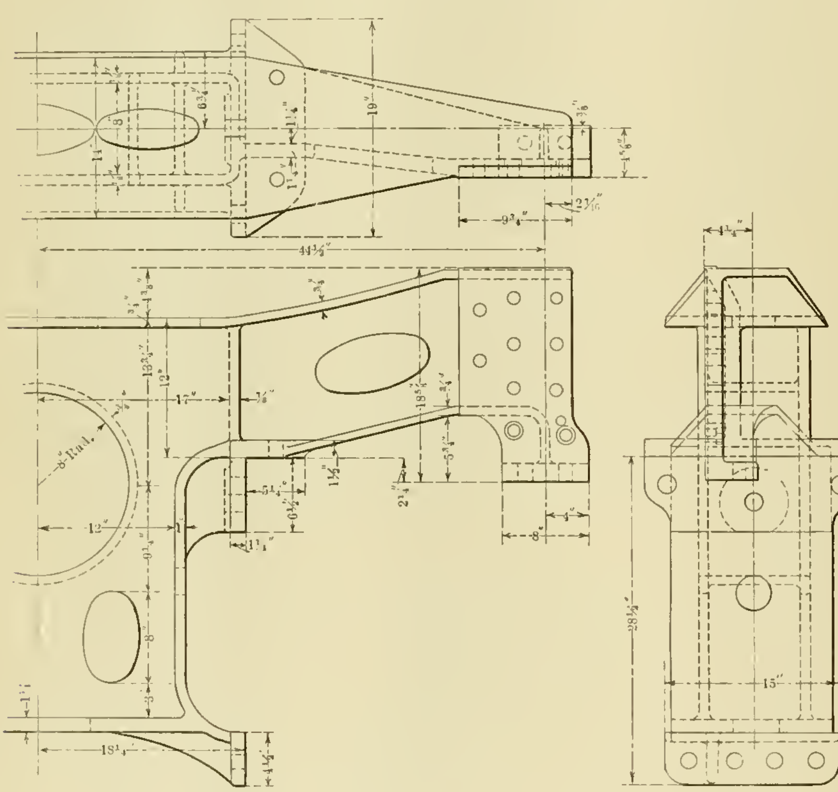
Besides relieving the main boiler bearing of the load which they support, the floating columns throw a certain load on the equalizing bolts in the rear of the frames; since the three supporting points constitute a system of support similar to the balanced beam, with the main boiler bearing as the fulcrum, the loads carried in the supporting columns and the equalizing bolt as the weights applied at either end. Consequently, if the system is in equilibrium, for any load supported by the floating columns, the equalizing beam must receive a load having the same proportion to the other as the respective distances of the floating columns and the equalizing bolts from the main boiler bearing have to each other. As the sum of the loads supported at each of the three points is equal to that part of the weight of the boiler which is carried on the front system, the total amount of the load removed from the main boiler bearing, by the introduction of the floating balance device, is equal to the sum of the load supported by the columns themselves and that thrown on the equalizing bolts.* In this engine, the floating columns are 52 in. from the main boiler bearing, and the equalizing bolts are 65½ in., so that with 30,000 lbs. supported by the columns, about 54,000 lbs. is removed from the main boiler bearing.

In passing through curves, the horizontal component of the force exerted by the springs tends to counteract the increasing resistance of the centering spring, and thus maintain a practically uniform side resistance on curves of different radii.

In engines of the articulated type of ordinary weight, the floating balance device is not necessary, but in designs of such enormous weight as the engine here illustrated, where the bearing pressure on the boiler support would otherwise be excessive, its distinct advantage is apparent.

The side spring buffers are located in the pocket casting of the articulated connection, one on either side, and as far apart as possible. They are so designed that when the engine is on a tangent the buffers just touch the bumper castings bolted to the cast steel crosstie at the ends of the rear frames. Thus, when the engine enters a curve one or the other of the buffer springs is compressed.

When the engine is curving, these buffers serve to direct the pushing force through the center of the wheel base of the front engine instead of through the flange of the outside forward driving wheel as it would be were they not applied. In pushing, the resistance of the head load tends to swing the front system about the center of its wheel base when the engine is passing through a curve, thereby increasing the flange friction of the front driving wheels. The action of the spring buffer is to counteract this side push of the load ahead and thus reduce the resistance.



CAST STEEL GUIDE YOKE AND FRAME BRACE—D. & H. LOCOMOTIVE.

In cases where the wheel base is comparatively long, as in the present instance, and the engine is engaged in pushing service, these buffers have been found to be very effective.

Apart from its enormous size, the boiler is of special interest because of the careful attention with which every detail of the design is worked out, to provide the greatest efficiency. It is of the radial stayed type with conical connection sheet. At the first course the barrel measures 90 in. in diameter outside, while the outside diameter of the largest course is 102 in. The barrel is fitted with 446 tubes, 2¼ in. in diameter and 24 feet long. The arrangement of the tubes is clearly shown in the illustrations of the boiler cross section. The bridges between the tubes are ⅞ in. wide.

The boiler incorporates a 4-foot combustion chamber, which is radially stayed to the shell of the boiler. Ample space is allowed between the combustion chamber and the shell of the boiler on all sides to insure good circulation of the water. The width of the water space is not less than 8½ in. at any point and increases to 11¼ in. at the bottom. Over the crown of the combustion chamber and down to the second row of staybolts above the center line of the boiler flexible staybolts are used. All the plates of the boiler shell are, of course, very thick, the heaviest plate being 1 3/16 in. and the lightest 1 in. The firebox is 114 in. wide and 126⅛ long, and provides a grate area of 100 square feet.

Two Chicago sight feed flange oilers are provided for oiling the flanges of the front and back wheels of each system when the engine is passing through a curve. These are located on the back head of the boiler and oil is fed from them by steam pressure through a pipe line, from which there are leads to the above mentioned wheels.

A single firedoor is provided in the firebox, equipped with a Franklin automatic opener. Iron sliding doors are provided at the back of the cab, which may be closed when the engine is backing.

The tender is fitted with a water bottom tank of large capacity. The tank carries 9,000 gallons of water and the coal space holds 14 tons of coal. In the design of the tender frame

* For a discussion of the weight distribution of Mallet compounds, see AMERICAN ENGINEER, Feb., 1909, page 61.

special care was taken to provide a strong and rigid construction. The longitudinal sills are constructed of 15 in. steel channels weighing 33 pounds to the foot, and top and bottom cover plates are used. Both the front and rear bumpers are of cast steel. The tender trucks are of the four-wheel arch bar type, the design following the Delaware & Hudson Company's standard practice, and have a carrying capacity of 100,000 lbs. each.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	105,000 lbs.
Weight in working order	445,000 lbs.
Weight on drivers	445,000 lbs.
Weight of engine and tender in working order	611,800 lbs.
Wheel base, driving	14 ft. 9 in.
Wheel base, total	40 ft. 2 in.
Wheel base, engine and tender	75 ft. 7¼ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.23
Tractive effort × diam. drivers ÷ heating surface	807.00
Total heating surface ÷ grate area	66.29
Firebox heating surface ÷ total heating surface, per cent	5.31
Weight on drivers ÷ total heating surface	67.00
Volume equiv. simple cylinders, cu. ft	26.00
Total heating surface ÷ vol. cylinders	254.00
Grate area ÷ vol. cylinders	3.85
CYLINDERS.	
Kind	Compound
Diameter	26 and 41 in.
Stroke	28 in.
VALVES.	
Kind, H. P	Piston
Kind, L. P	Bal. Slide
Diameter, H. P	14 in.
Greatest travel	6 in.
Outside lap, H. P	1 1/16 in.
Outside lap L. P	1 in.
Inside clearance, H. P	5/16 in.
Inside clearance, L. P	7/16 in.
Lead, constant	3/16 in.
WHEELS.	
Driving, diameter over tires	51 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 12 in.
BOILER.	
Style	Conical
Working pressure	220 lbs.
Outside diameter of first ring	90 in.
Firebox, length and widtb	126⅛ x 114 in.
Firebox plates, thickness	⅜ and 9/16 in.
Firebox, water spacc	F. 5, S. 4, B. 4½ in.
Tubes, number and outside diameter	446—2¼ in.
Tubes, length	24 ft.
Heating surface, tubes	6,276 sq. ft.
Heating surface, firebox	353 sq. ft.
Heating surface, total	6,629 sq. ft.
Grate area	100 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	16 ft.
Center of boiler above rail	10 ft.
TENDER.	
Tank	Water Bottom
Frame	15 in. Chan.
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons

THE DRAFT GEAR SITUATION.

To the Editor:—

Mr. Adams' pertinent observations * upon the draft gear situation read like a challenge to the draft gear people to make good. The situation, however, is as though one should go to an ordnance engineer and ask him to design a gun that would carry a shot ten miles, and then says: "Now the gun must only be so heavy, so long, have only so much recoil and use so much powder," all of which would make the work required of the gun impossible. The engineer would undoubtedly give you the laugh, but this is just about what the draft gear engineers have been up against, and if the perfect draft gear has not been produced, this is the reason. There probably have been as much, if not more, brains, time, money and effort spent upon the subject of absorbing the shocks of railway cars, as on any other of the elements entering into modern car construction, and as early as the '60's patents began to be issued covering this ground. The essential elements, so well put by Mr. Adams are described almost as well in a patent issued to Pennock in 1867.

During the last two years there have been many changes made in the construction of draft gear, as it has been found that gears that will perform well under slow impact are practically worthless under a quick and heavy blow; also that gears with too easy a starting motion do not absorb sufficient work to prevent a heavy shock, even though the final capacity of the gear was very high, for the acceleration of the blow must be lessened early in the movement to prevent a heavy blow being delivered to the car frame, notwithstanding the gear might be rated at 300,000 pounds capacity. Up to 1907 there had not been a more comprehensive review of the draft gear situation than that given by Mr. A. A. Stucki in his valuable paper before the Railway Club of Pittsburg in December of that year, and the points of the perfect gear as outlined by him, may well be taken, and are being taken, as the standard for which draft gear engineers are working. The requirements of a perfect gear he gives as follows:

"Easy motion at the beginning of the stroke. This is necessary to absorb the small oscillation and lurchings constantly taking place during travel which will rack the car if ignored."

"The recoil should be small, so as to reduce the back lashing after the blow. None the less, the greatest care must be taken that this recoil is sufficient to open the gear under any and all conditions, else you might just as well have a solid block in place of a draft gear."

"Simplicity is one of the most important principles in car construction, and if we had to choose between two gears, one consisting, say, of 5, the other of 20 pieces, everything else being equal, there should be no question as to choice."

"The bearing surfaces should be large, so as to minimize wear."

"The bearing surfaces should be kept flat and well braced so as to get equal pressure all over."

"The design should be of such a nature that machining of the different parts is unnecessary. Such machining is an indication that a delicate adjustment is necessary. The most reliable device is undoubtedly the one that can be made in the foundry and shops, like any other part of the car and which will work in spite of everything being rough, and conditions far from what they really should be."

When the gear closes, all yielding and minor parts should be out of action, and the blow should be transmitted through solid castings to the car just the same as if there were no draft gear present."

Yet with all the experience, data, and basic requirements before them, the draft gear engineers have to confine themselves to a limited space, travel and weight, and must design accordingly.

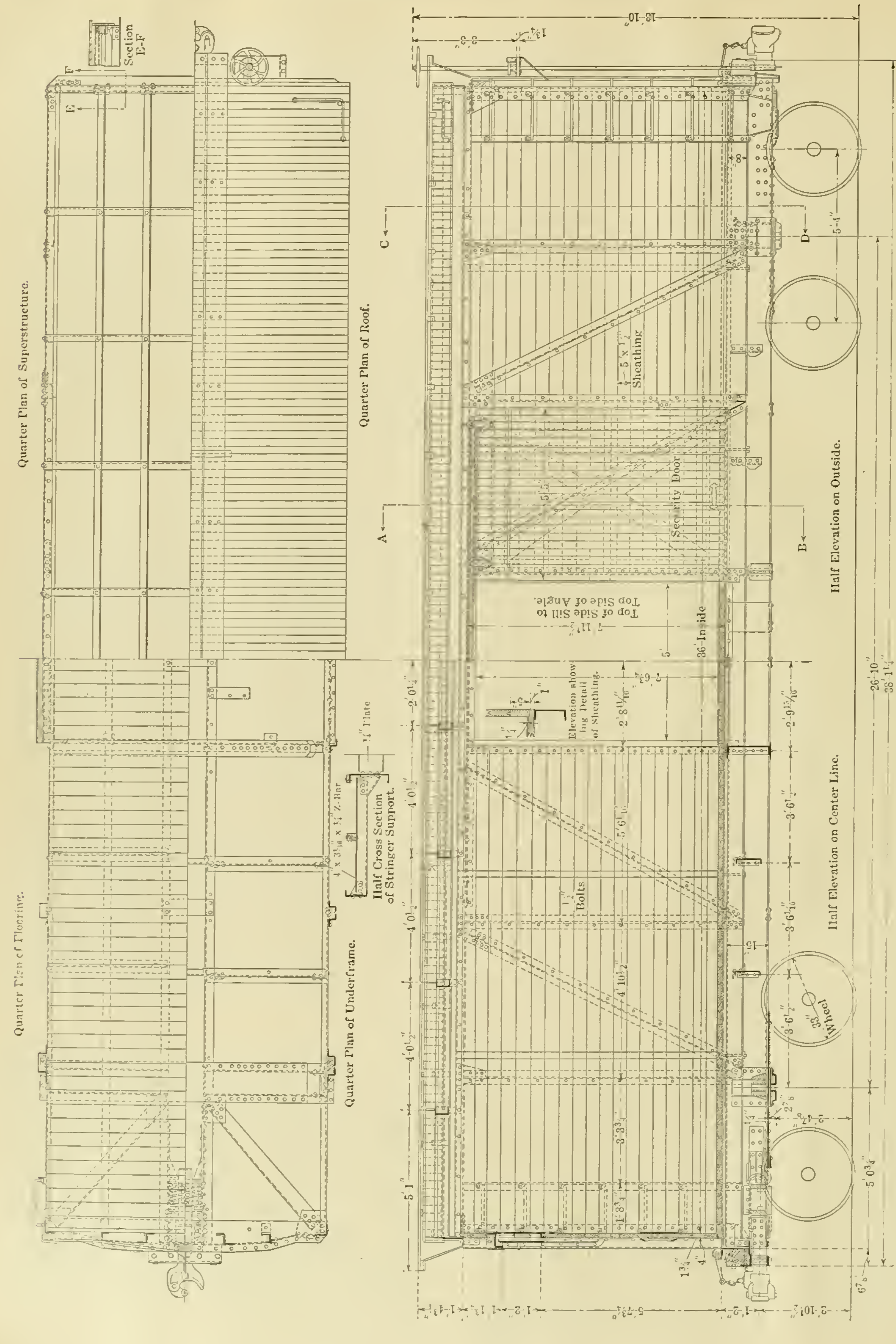
The exhaustive and most interesting tests made during the summer of 1908 on the Southern Pacific Railway, and the later experiments of Col. B. W. Dunn, Chief Inspector of the Bureau for Safe Transportation of Explosives, and other Dangerous Articles, demonstrated beyond all doubt the value of the friction draft gear in absorbing shocks. If the engineers working on the problem have not produced the perfect gear, it is because of the limitations under which they have been compelled to work, but some think they have it almost perfect, and there may be some gears that Mr. Adams has not seen.

W. B. Waggoner.

Cleveland, Ohio.

Eight Locomotives to Six Machinists.—We get eight engines out per month with but six machinists on the floor. We work piecework and have eight pits, and every pit has a drop. There are two handy men who dismantle the engine with the exception of the ashpans, front ends and pipe work. There is a handy man in the boiler department who takes care of the ashpans. Besides the six machinists on the floor, we have three handy men. Another man is what we call a roustabout. In our motion work the man that handles the links completes the job and sets the valves. The rods are taken down by the handy man and delivered to the fitting shop; the cab mountings are handled in the same way. There is a machinist on the floor that puts the cab work up, but he does not overhaul it. There is mighty little left for the six men on the floor.—*J. A. Boyden at the General Foremen's Convention.*

* See American Engineer, April, 1910, page 141.



BOX CAR WITH STEEL FRAME. THE FLOORS, SIDES, ENDS AND ROOF ARE WOOD. BUILT BY THE CANADIAN CAR AND FOUNDRY COMPANY FOR THE CANADIAN PACIFIC RAILWAY.

GENERAL VIEW OF CANADIAN PACIFIC STEEL FRAME BOX CAR.

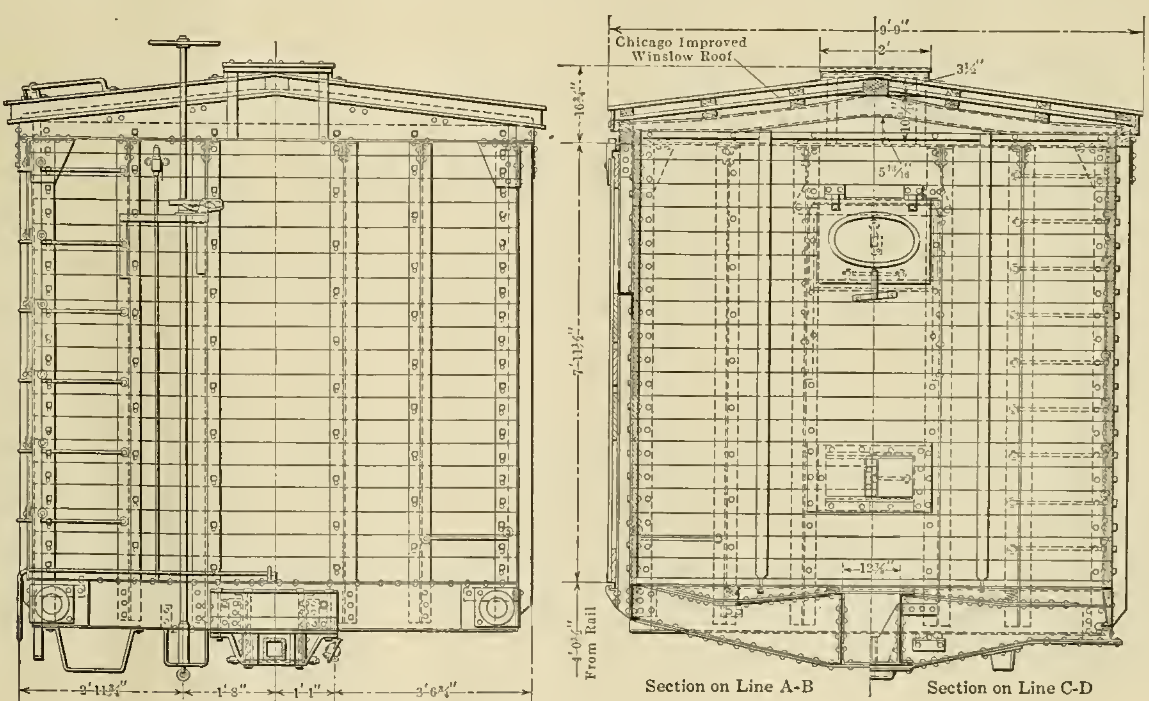
STEEL FRAME BOX CARS.

Canadian Pacific Railway.

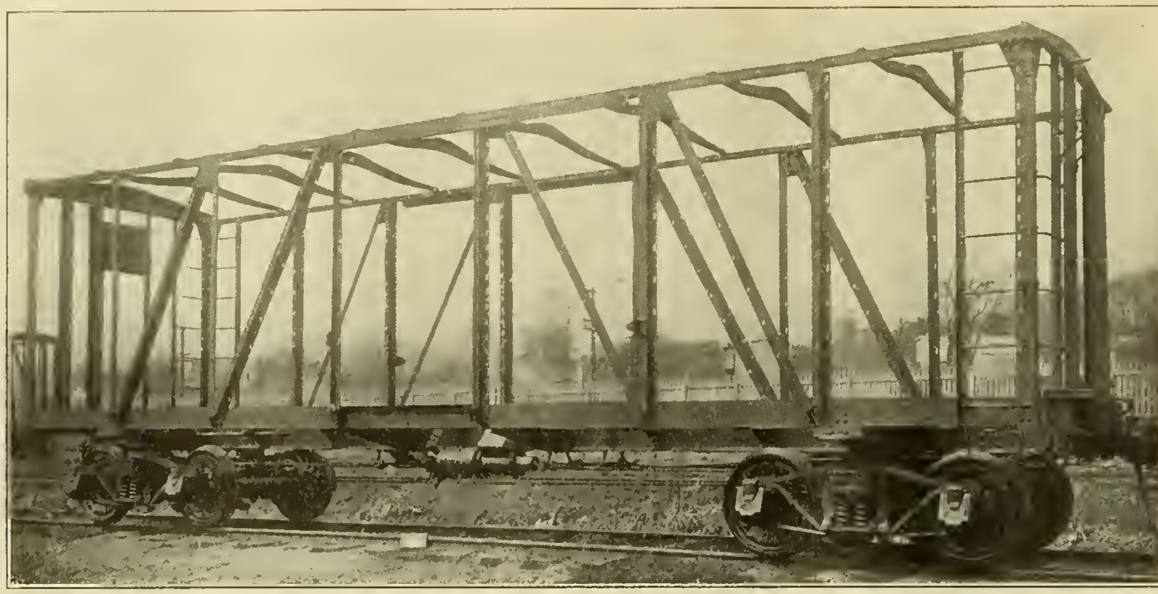
The Canadian Pacific Railway has in service, or on order, two thousand five hundred 80,000 lb. capacity box cars, which were built by the Canadian Car and Foundry Company of Montreal. These cars are 36 ft. inside length and have a steel underframing and steel side and roof framing, the floor, side sheathing and roof covering being of wood. They weigh 36,700 lbs.

Two 15 in. channels set 12⅞ in. apart and continuing from end sill to end sill form the center sills. The side sills are 8 in. channels and are set with their top face 1½ in. above the level of the top flange of the centre sills. The other longitudinal sills in the first order of 500 cars were 4 in. Z bars located mid-way between the side and centre sills and resting on top of the bolsters and cross bearers. In the next 1,000 cars a 3 x 4 in. wooden stringer was substituted and in the 1,000 now being built the Z bar has again been used.

The bolster, which is shown in one of the illustrations, is of the pressed steel diaphragm built up type, having ½ in. cover plates top and bottom. The bolsters extend below and beyond the side sills, which are connected to them by angles and corner brackets, as shown in the illustration. Near the centre of the underframe just below the door posts are two built up cross-bearers composed of a pressed steel diaphragm with a 6 x ½ in. cover and bottom plates, neither of which extend all the way to the side sill connection. Both the bolsters and cross bearers are constructed to permit the intermediate sills, 4 in. in depth,



END ELEVATION AND CROSS-SECTION OF STEEL FRAME BOX CAR.

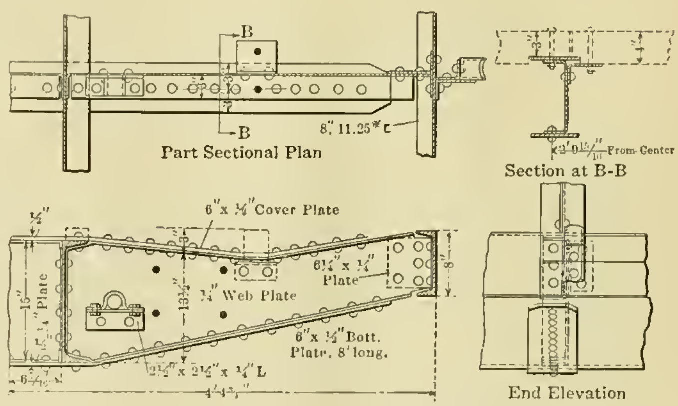


VIEW OF STEEL FRAMING BEFORE SHEATHING OR ROOF WERE APPLIED.

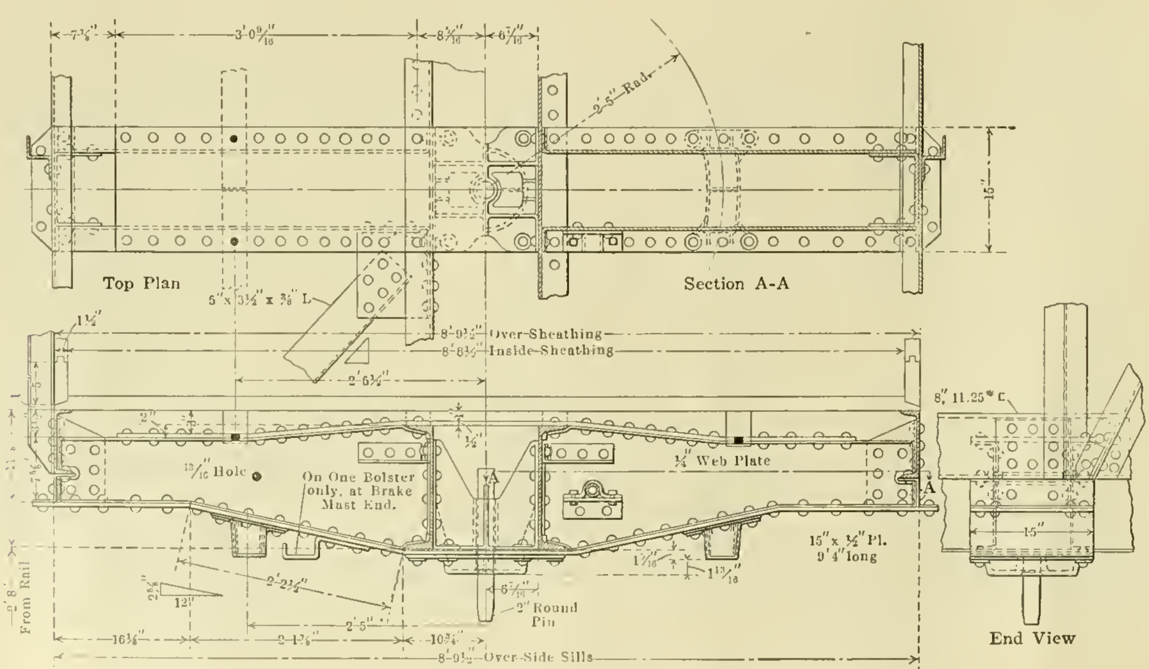
to rest upon them. The end sill is a channel pressed out so as to permit the Z bar end post being secured back of it. Between the bolsters and cross bearers are two cross braces consisting of channels secured between the side and centre sills. There is also a diagonal brace from the corner of the car to the connection between the centre sills and bolster.

The wooden floor is nailed to 1 in. wooden stringers secured on top of the centre sill channels and bolted or nailed to the intermediate longitudinal sills. It is not fastened directly to the side sills, but is held down by the side sheathing, the connection at this point being shown in the small detail given in the illustration of general elevation.

The side framing is composed of 3 in. standard Z bars secured outside of the side sills and to an angle iron plate, the top connection being reinforced with a gusset plate. The corner posts are 5 x 5 in. angles and the two centre end posts are 4 in. Z's, the intermediate end posts being 3 in. Z bars. These are secured to the steel end carlin, which is of the Z section. The carlins are of pressed steel in U section, being arranged to lip over the



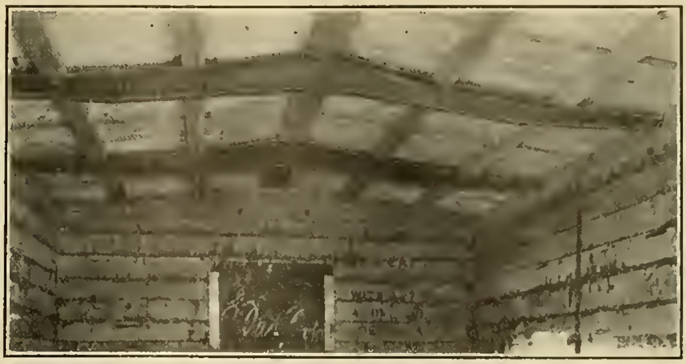
DETAILS OF CROSS BEARER.



DETAILS OF BODY BOLSTER ON C. P. R. STEEL FRAME BOX CAR.

side plate and are secured by a rivet through the vertical flange of the plate.

The inside sheathing is tongued and grooved, 1½ in. x 5 in. pine being bolted to the framing. The holes in the steel parts are slotted, and there are tie straps hooked over the top of the sheathing, carried down inside through the side sills and secured with nuts. The inside sheathing extends 3 in. above the bottom of the plates and as it dries out or loosens up the bolts are slacked off and the nuts on the bottom of the tie bars being drawn up will permit the tightening of the sides and ends of the car to the total of 3 in. without leaving an opening at the top. There are two of these tie bars at each end and four on either side.



INTERIOR VIEW SHOWING PRESSED STEEL CARLINS.

Chicago improved Winslow roof has been fitted to the car, the construction being clearly shown in one of the illustrations. They are provided with a pressed steel hinged end door near the top and a small sliding door near the bottom of the ends.

The trucks are of the standard Canadian Pacific Railroad type, equipped with 750 lb. wheels. They have McCord malleable iron journal boxes; Barber roller device; Susemihl frictionless side bearings; Simplex bolsters and brake beams, and American Steel Foundries steel back brake shoe.

The specialties on the car body are Westinghouse air brakes; Simplex couplers and Security side door fixtures.

A GENERAL LOCOMOTIVE INSPECTION

AN ACCOUNT OF THE METHOD OF PROCEDURE, SOME OF THE RESULTS AND THE CONCLUSIONS FOLLOWING A DETAILED INDIVIDUAL INSPECTION OF OVER FIFTEEN HUNDRED LOCOMOTIVES OF ALL TYPES AND SIZES.

By R. H. Rogers.

IN THREE PARTS—PART 2, WHAT IT DEVELOPED.

In the preceding article* the object of the inspection, so far as can be estimated by the writer, was commented upon, and its scope and presentation outlined in some detail. It is now intended to review the conclusions reached on each division after its locomotives had been inspected, and the following is a summary of the conditions existing thereon as they appealed to the inspector, mention being made of conditions both detrimental and the reverse. Those in the detrimental class are the features which most demanded correction in that territory, and naturally embody the chief interest. In the favorable class they are examples of adequate maintenance, which fairness if nothing else dictated, should be mentioned in the final reports from each division.

DIVISION A.

93 Engines. Good, 46; Fair, 30; Poor, 8; Shop, 9. Efficient, 81%.

Detrimental Features.

(1) Large number of engines with thin tires; 26, or 28%.
(2) Excessive slack between engines and tenders, long drawbars.
(3) Engines with pressed steel tender truck frames broken.
(4) Number of cast iron driving wheel centers broken and banded.

Favorable Features.

(1) General efficient condition of power.
(2) Attention to details: oil cups, cotter pins, metallic packing.
(3) Adherence to standard practises, and quality of back shop output.
(4) Division self-sustaining through its own back shop resources.

DIVISION B.

80 engines. Good, 42; Fair, 21; Poor, 11; Shop, 6. Efficient, 79%.

Detrimental Features.

(1) Flange wear of driving tires; due largely to careless setting.
(2) Poor condition and care of driving box shoes and wedges.
(3) Excessive lateral motion in engine truck and driving boxes.

Favorable Features.

(1) No bad cast iron tender wheels on the division.
(2) Absence of sharp flanges on engine truck wheels.
(3) Valves kept well squared up on engines of all classes.
(4) Prompt correction of valve and cylinder packing blows.
(5) Speed in back shop operations: setting up and stripping engines.

DIVISION C.

130 engines. Good, 63; Fair, 40; Poor, 17; Shop, 10. Efficient, 79%.

Detrimental Features.

(1) Poor condition of driving box shoes and wedges, 28 engines.
(2) Flange wear of driving tires. Little attention paid to proper spacing: no verified gauges, and sticks of wood used for this purpose in the wheel gang.
(3) Inadequate wiping of engines; very poor, even passenger engines.

Favorable Features.

(1) Absence of lateral motion in engine truck boxes.
(2) Good condition of cast iron tender wheels.
(3) Back shop output good, but lacks thoroughness in details.
(4) Adherence to shop practise cards.
(5) Ash pans and appurtenances in good condition.
(6) New standards promptly embodied.

DIVISION D.

121 engines. Good, 51; Fair, 50; Poor, 13; Shop, 7. Efficient, 83%.

Detrimental Features.

(1) Poor condition of switching power, through inadequate care.
(2) Poor condition of driving box shoes and wedges.

Favorable Features.

(1) Clean engines.
(2) Attention to small details: oil cups, sand pipes, cylinder cocks, etc.
(3) Cast iron wheels in good condition.
(4) Absence of flange wear.
(5) Adherence to standard practises.

DIVISION E.

97 engines. Good, 58; Fair, 20; Poor, 10; Shop, 9. Efficient, 81%.

Detrimental Features.

None of any moment: there was, in fact, nothing to criticise except that the power was poorly wiped, and the care of the oil cups and other small details showed lack of attention.

Favorable Features.

(1) Good condition of driving tire flanges.
(2) Honesty of thorough repairs.
(3) Incorporation of standards.
(4) Close supervision.

DIVISION F.

42 engines. Good, 14; Fair, 10; Poor, 8; Shop, 10. Efficient, 57%.

Detrimental Features.

(1) Poor condition of rod brasses, due to lack of attention.
(2) Crossheads and guides in same shape through same cause.
(3) Three broken frames in service and inadequately patched.

* May, 1910, page 181.

FAVORABLE FEATURES.

(1) Absence of flange wear in driving tires.
(2) General good condition of cast iron wheels.
(3) Absence of lateral motion in engine truck wheels.
(4) Good cylinder packing.
(5) Oil cup tops on, and well cared for generally.
(6) Good work of light freight power in road service.

DIVISION G.

108 engines. Good, 60; Fair, 26; Poor, 18; Shop, 4. Efficient, 79%.

DETRIMENTAL FEATURES.

(1) Poor valve motion on class z-20 engines.
(2) Engines in service with broken frames.
(3) Inadequate wiping.
(4) Oil cups poorly maintained.

FAVORABLE FEATURES.

(1) Absence of flange wear, due to care in setting tires.
(2) Good quality of back shop work.
(3) Good condition of driving box shoes and wedges.
(4) Percentage of poor tender wheels (cast iron) low; crossheads and guides in fair condition; no driving springs cutting fire-box, and pedestal binders well fit and in good condition.

DIVISION H.

152 engines. Good, 82; Fair, 34; Poor, 19; Shop, 17. Efficient, 76%.

DETRIMENTAL FEATURES.

(1) Improperly fit pedestal binders.
(2) Smoke box fronts in poor condition.
(3) Poor condition of driving box wedges and rods: freight engines.
(4) Excessive lateral motion in driving boxes.
(5) Freight engines wiped only in spots; oil cups not in good condition; injector feed pipes poorly braced, unnecessary slack between engines and tenders because drawbars want shortening.

FAVORABLE FEATURES.

(1) Incorporation of standard practises.
(2) Absence of flange wear of driving tires.
(3) Good condition of passenger power.
(4) Tight cab fittings.

DIVISION I.

95 engines. Good, 41; Fair, 21; Poor, 13; Shop, 10. Efficient, 73%.

DETRIMENTAL FEATURES.

(1) Poor condition of rod brasses and knuckle pins.
(2) Sharp flanges on driving tires, due to improper spacing.
(3) Preponderance of lateral motion in driving boxes.
(4) Sharp flanges on engine truck wheels.
(5) Poorly wiped freight engines.

FAVORABLE FEATURES.

(1) Care taken of compound engines in the renewal of cylinder packing.
(2) Good condition of motion work.

DIVISION J.

99 engines. Good, 47; Fair, 25; Poor, 12; Shop, 15. Efficient, 72%.

DETRIMENTAL FEATURES.

(1) General poor condition of engines not immediately around the principal shop on the division.
(2) Large number of broken frames in service without temporary repairs.
(3) Excessive lateral motion in driving boxes.
(4) Poor condition generally of rod brasses and connection.
(5) Engines with thin tires; below the standard limits.

FAVORABLE FEATURES.

(1) Absence of flange wear of driving tires.
(2) Absence of lateral motion in engine truck boxes.
(3) Smoke box front ends in good condition.
(4) Thoroughness of back shop work.

DIVISION K.

323 engines. Good, 145; Fair, 105; Poor, 38; Shop, 35. Efficient, 78%.

DETRIMENTAL FEATURES.

(1) Neglect of guides and crossheads.
(2) Poor condition of freight power.
(3) Damage to frames by spring hangers.
(4) Clamped and patched broken parts.

FAVORABLE FEATURES.

(1) Absence of lateral motion in engine truck wheels.
(2) Good condition of cast iron wheels.
(3) Close adherence to standard practises.
(4) Outlying points protected with good power.
(5) Close inspection in roundhouses.

DIVISION L.

98 engines. Good, 66; Fair, 23; Poor, 5; Shop, 4. Efficient, 91%.

DETRIMENTAL FEATURES.

(1) Patched, banded and clamped broken parts.
(2) Flange wear of driving tires.
(3) Broken flanges on driving box shoes and wedges.
(4) Improper practises in the fit of driving boxes.

FAVORABLE FEATURES.

(1) Clean engines.
(2) Absence of lateral motion in engine truck and driving boxes.
(3) Careful adjustment of driving box wedges and adequate maintenance.
(4) General good condition of rod brasses and connections.
(5) Lucid and comprehensive office records.
(6) Familiarity on division with actual condition of power.

For those interested in locomotive maintenance there is a limitless field for analysis afforded in the consideration of this presentation of laboriously gathered facts. Confining merely to the detrimental features in the reports quoted, each item in itself is sufficiently suggestive for an article and a discussion, but, as the most recurrent items in the individual engine reports dictated these final conclusions for each division, so must the same in these summaries afford the clue to what must be combated to secure true locomotive efficiency anywhere. The A. B. C. railroad, in fact, need no longer be prominently associated with these articles, as it is logically assumed that the notes gathered on the wear as exhibited by over fifteen hundred fairly modern locomotives, employed in representative freight and passenger service, must to a greater or less degree universally apply, or at least a universal application may be made of the inferences to be drawn therefrom. It is therefore the intent of this article not to discuss the shortcomings or the efficiency of the A. B. C. railroad, but to analyze these detrimental features as broadly representative sources of trouble to motive power management, no matter where located.

After eliminating from the general detrimental features which have been portrayed those which are in a measure controllable, and whose mention simply implies neglect, or lack of adequate organization, the remaining items resolve into the following:

(1) Excessive lateral motion in driving boxes, and to a less extent in engine truck boxes.
(2) Improper condition of driving box shoes and wedges.
(3) Excessive and unwarranted flange wear of driving tires.
(4) Continuance of broken frames in service.
(5) Lost motion in rod brasses and connections.

The above in varying degrees were encountered by the inspector on each division, and may be safely assigned as the principal elements in locomotive deterioration, simply because they were the most recurrent items in the entire inspection.

EXCESSIVE LATERAL MOTION.

This is a most vexatious problem, as a glance behind the driving wheel of almost any locomotive will mutely attest, and singularly enough there is little uniformity among the practises employed to combat it. It was so prominent, indeed, in connection with the fifteen hundred and twenty-six locomotives covered in this inspection, that its mention became necessary in the reports of nine hundred and twenty-one engines, with the further explanation that it was passed unnoticed by the inspector unless the total in any pair of wheels was one-half inch or more. Some of the engines only three months out from general repairs had three-eighths inch end play, although put up with only one-sixteenth inch on each side, or a total of one-eighth inch to start with, and many had a total of one inch, or even an inch and a half, but these latter were, of course, extreme cases.

At the time of this inspection the A. B. C. railroad employed two half circle cast iron liners on the hub of the driving wheel center, and a mixture of special hard babbit for a driving box liner of the following composition:

Tin	86%
Copper	7%
Antimony	7%

Hard as this was, so hard that it would scarcely stick together, it nevertheless proved inadequate, and the repeated mention in the individual engine reports of "excessive end play" inclined the management toward the thought of a more enduring metal for the wearing face of the driving box. Naturally in this connection brass was suggested, but the method of its application to the box resolved into quite a problem. The recommendation finally adopted was that ingot brass should be melted and poured on; this to save the laborious application of a cast liner by patch bolts, and of course the money incidental to the operation.

The only argument in favor of standard cast brass liners to be carried in stock was that the melting of the brass could be restricted to some central shop, and the liners ordered on requisition, but the presentation of the expense to drill some twenty-four holes in the box, tap them, and prepare patch bolts to hold the liner, was in the aggregate sufficiently convincing for authority to be given each shop to melt its own brass.

For melting purposes the inspector recommended the crucible method. This suggestion was not favorably received at first, as the thought was entertained that in going to crucibles a bill of expense would be run into which would prohibit the system. In the meantime experiments were conducted in one of the shops to melt the brass in an oil furnace with a clay lined ladle, but not sufficient heat could be obtained, and this would no doubt apply to any furnace with less than 16 or 18 oz. pressure in the blast. An easy way out of the difficulty, however, was eventually found by using the spring handing furnace, with which each of the principal shops on the A. B. C. railroad was equipped.

In order to dismiss the fear incidental to the short life of crucibles the writer experimented with various crucible washes, and finally hit on the following combination:

1 part pulverized soft fire brick,
2 parts fire clay.

This is placed in a half-barrel and water added to form a mortar. Apply it to the crucible ⅛ inch thick, and dry in core oven. Additional layers may be applied if it is thought that the crucible requires it.

The writer feels safe in the assertion that this wash will prolong the life of a crucible 100%. Not one when so treated, and of course intelligently handled, will ever let go in the furnace. The coating generally lasts two heats and sometimes more.

Another wash which was suggested while these experiments were under way is as follows, but it has not been tried, and is merely mentioned for what it may be worth:

1 part pulverized soft fire brick,
1 part old crucible,
1 part fire clay.

The treatment of the crucible with this mixture to be the same as that outlined in the wash which was adopted.

Having thus disposed of the problem of melting the brass at all points where back shop work was done, and prolonging the life of the crucibles as well, the next feature was to apply the melted brass to the box in the cheapest and most effective manner. To this end the writer after due reflection prepared and submitted the following shop practise card which was eventually adopted as a standard practice:

All driving boxes to be prepared for brass liners as follows: No less than seven one-inch holes, equally spaced along the center line of the circular groove to be drilled three-quarters of an inch deep in the end play face of the driving box. This drilling must be done with the side or end of the box nearest to the drill elevated on a two-inch strip; this to secure an appreciable angle in the drilled hole toward the center of the box, for the purpose of anchoring the brass liner when poured.

The above is no doubt self-explanatory, but the idea in brief is to slant the drilled holes toward one another: thus when the brass is poured from the crucible it can never come off, as these "tits" are opposing. his practice was eminently successful from the start. The piece work price agreed upon for drilling each box as above indicated was 8 cents, and for pouring the brass, 6 cents. Thus $1.12 covered the labor incidental to applying brass end play liners to eight driving boxes, exclusive, of course, of machining the face of the liner. The immovable nature of the latter when so applied is indicated by the fact that as an experiment it required hard sledging for twenty minutes, with two mauls and a handle chisel, to break one of them off. The writer has never known one to come loose or lose off in service, and there is no need for comment on the superiority of brass over special hard babbit in wearing qualities for this particular part. This practise is equally applicable to engine truck boxes.

So far as the liner on the hub of the driving wheel center is concerned, there is little to criticise in the A. B. C. standard of two half circle pieces of cast iron, secured by patch bolts of iron or brass (not copper). The requisite, of course, is to secure something which will protect the center from wear, and not fall off. In view of the latter probability these liners should always be in two pieces, thus affording an opportunity for the roundhouse to take care of on the drop pit any case where one or both of them may be lost, which it could not do if they were solid, or in one piece, as has been frequently observed. The general inspection of the A. B. C. railroad indicated only twenty-seven instances where these half-circle cast iron hub plates were missing; hence they may be defined as adequate for the purpose intended.

Before dismissing this subject it is believed that the rapid wear of the special hard babbit when employed as driving box end play liner is much more intensified through its peculiar affinity for grit. While not offering this as a positive assertion, experience leads to the belief that grit clings readily to a babbit surface, and thus grinds out the part, while it seems to fall from a brass liner. The substitution of brass for babbit appeals as a move in the right direction and in the consideration of all the sound arguments which can be advanced for its use it is amazing that it is not of universal application. The writer believes that should another inspection be made of the A. B. C. railroad the end play problem would appear as easily controllable, instead of looming up as the predominating feature in deterioration, as it did in this instance.

DRIVING BOX SHOES AND WEDGES.

At the time this inspection was made the individual reports indicate that no less than seven hundred and sixty-three engines embodied driving box shoes and wedges in a condition far below the requirements of any standard of maintenance for these parts. Criticism was principally leveled at the fact that they were allowed to run on at least two divisions when set up as far as they would go, that is, tight against the top of the frame. In such instances comment is, of course, superfluous, as they simply imply lack of organization, or the failure to properly view in their true importance the internal disturbing factors introduced in the locomotive through their continuance. But from a strictly mechanical standpoint the following may be noticed in the examination of the engines of any railroad where they are engaged in heavy service: (1) Shoes and wedges heavily "shouldered" above the driving boxes, (2) a very large percentage with flanges broken off.

In explanation of the shouldered feature mentioned this is intended to refer to that portion of the shoe or wedge more prominent in the former as it extends the entire length of the pedestal, which remains above the shoe and wedge faces of the driving box, and hence escapes being affected by the "rub" of the latter as the box shifts in the jaws while the engine is running. Sometimes this inequality in wear amounts to as much as one-eighth inch, and it is decidedly objectionable, as if an attempt is made to properly adjust the wedge under such conditions it will likely be stuck with the first inequality of track which will elevate the box to come in contact with the unworn or shouldered portion of the shoe. It is of tremendously far-reaching effect, because the engineers with a lively recollection of unpleasant experiences, hesitate to set up their wedges, knowing the result as above intimated, and in consequence the majority of heavy freight engines in this country, if "thumped" under steam, will likely exhibit a heavy pound in the driving boxes between the shoe and wedge faces. The wretched condition of rod brasses and knuckle joint connections on many of these engines will mutely attest that the rods are doing all the work, due to the unstability of the driving boxes arising from loose wedges which will not run set up owing to the inequality in the wearing face of the shoe.

It is a matter, however, easily and cheaply corrected, and scarcely another machine operation can be mentioned which in the end will yield such satisfactory results. The following remedy is suggested as a shop practise card:

In machining shoes and wedges a 3/32-inch cut must be planed or milled on the wearing face, 4 inches in length (not arbitrary) measured from the top. In certain cases it may be advisable to treat the bottom of the wearing face in the same manner.

It will be recalled that this practise is invariably followed in planing guide bars, in what may be called "end clearance" between them, and which permits the crosshead to be pulled to the extreme or the "striking" points. When embodied in shoes and wedges as above outlined it permits a perfect adjustment of wedges, and is readily affected whenever these parts are down, but of course properly belongs to the time when the engine is receiving general repairs. This train of thought was suggested following an inspection where the general wedge conditions were unduly flagrant, and in reply to criticism it was advanced that they "could not be set up without sticking"; without question absolutely correct, as has been explained.

In regard to the second ever present feature in connection with shoes and wedges, viz., broken flanges, the question arises whether or not this may be construed as anything objectionable or detrimental, but waiving this possible argument, the fact remains that something is broken, and there must necessarily be evinced a weakness repellant to advanced mechanical ideas and procedure. It may not be credited, but the writer has seen a 4-4-0 light passenger engine with each and every flange broken off the total of eight shoes and wedges which this wheel arrangement implies.

The reason for this, and all other breakages of similar kind, is that not sufficient clearance exists between the flanges of the shoes and wedges and the pedestal legs, and between these flanges and the flanges of the driving boxes; in other words, a too much "straight up and down" proposition. With everything a "fit" the slightest cant of the locomotive frame in either direction, and there are lots of them even at reasonable speed imposes a prohibitive strain on all of these parts, to the extent that in extreme cases something must inevitably let go. This something is, of course, the comparatively weak cast iron flange of the shoe or wedge.

A good practice to follow, and which will result in reducing to a minimum the breakage of flanges, is to slightly taper the inner face of the driving box flanges from the center both ways to the ends. This total taper need not be over 1/16 inch, but this will be ample to take care of whatever rocking motion the driving box may assume when the engine is running. This is necessarily another back shop operation, and it is earnestly recommended, as there is nothing the roundhouse can do in combating the problem of broken flanges except repeated renewals of the shoes and wedges, which soon runs up a formidable bill of expense in addition to detaining the engine from road service.

Before this item is dismissed another feature must need be commented upon, and that is the neglect which generally associates with the proper care of wedges. Innumerable instances are recalled where the liners added from time to time to take up wear were "tacked" on, and in consequence had worked out and over the top of the driving box so that it would be practically impossible to oil the latter. It is no less than amazing after all the hard work has been done of taking down the binder, and often a driving spring as well, to remove the wedge, that the liner should be hastily stuck on with two insignificant ⅛ inch copper rivets, yet it is in evidence every day, although with the realization that the arrangement is scarcely permanent enough to take the engine out of the roundhouse. No liner should be allowed less than ⅛ inch thick, which is the minimum for an adequate countersink in the rivet holes; and no less than eight ¼-inch rivets, equally distributed, should be employed to secure it. The job is to take down and re-apply the heavy parts, and certainly nothing can be advanced against consuming sufficient time to fasten the liner so it will stay until another liner must be applied, which should mean four months at least, no matter what the character of the service may be.

The importance of properly maintaining this part is not underestimated by scarcely any railroad, and on the large majority of them the roundhouse organization provides for what is called a "shoe and wedge man," who with one or two helpers is charged with "keeping them up," not only so far as lining when required is concerned, but the proper adjustment as well. In such organization this man is supposed to keep an eye on all of the wedges under his jurisdiction, and in addition to doing the work in that line reported by the engineers and the engine inspector, to take the initiative when he notes anything in need of repair.

Theoretically, this may be all right, but in its practical working becomes largely a farce. With the possible exception of the steam pipes, the shoe and wedge job is the meanest and most disenchanting proposition on a locomotive. In recent years the binders have become tremendously heavy. They are generally fit with draw to the pedestal, are hard to wedge down, and very hard to pull up to where they must go to be re-applied properly. Many engines have underhung springs, and it is then necessary to remove the spring before starting on the binder. It is besides a strictly "pit" job, and every move is performed under the disagreeable environment of standing in cold water with hot water dropping from above. Naturally a shoe and wedge man, no matter how conscientious he may be, is only human after all, and in the absence of definite orders from some one regarding his work, is very liable to let the job go until it has reached distressing proportions, especially where the organization provides that he largely finds his own work.

After long consideration of this matter the writer recommends that specialists on the shoe and wedge job be discontinued. It is confidently believed that far better results will materialize by the roundhouse foreman handing these jobs as they occur to any one of the running repair hands who may be disengaged at the time. This will result in placing the foreman closer in touch with these parts, and he will watch and hurry the job, being desirous to secure the use of that running repair man on something else, whereas he could not use a regular shoe and wedge man on anything other than his work, a situation which creates indifference toward the latter.

This recalls that a surprising ignorance has often been noted on the part of roundhouse foremen in regard to the actual condition of the wedges in engines under their direct supervision. On one occasion the writer took a foreman for a walk along a string of engines on the ash pit, and pointed to the fact that five of these, all in heavy freight service, had one or more wedges set up as high as they would go, and the box playing backward and forward to the detriment of rod brasses and connections. He said, and honestly the writer believes, that he had not the slightest idea conditions were so bad, and that the engineers running these locomotives had not reported their wedges in need of lining. They were chain gang engines, and a review of the work book showed that reports of this nature were quite infrequent. The writer then requested the road foreman of engines to take the matter up with the engineers to learn why they had not brought the matter to the attention of the shop supervision, and the investigation in time developed that they had become indifferent since against their wishes the engines had generally been pooled. They added that when this procedure was established a "let-up" ensued all around, in the shop as well as in their former attention.

However this may be, there is no intention to offer an argument relative to the chain gang system, now generally prevalent, one way or the other, but the fact remains that the time-honored care of wedges which the engineers have apparently let go, the shop must now assume. One reason why things are so bad in this line is because the adjustment of wedges, at least, was generally attended to by the engineers, and the shop has not come to a full realization that they no longer experience the old interest.

The writer believes that for the present, at least, the only real solution for this problem is to station an inspector on the ash pit, for whose benefit the engine will be "thumped" under steam before the hostler brings it into the house. In this form of inspection the lost motion in any part is most apparent, and the report covering the condition of the wedges, or the pound of the driving boxes in the jaws, could reach the roundhouse foreman coincident with the arrival of the locomotive on its pit. This will effectually dismiss the excuse that they had not been advised of conditions which to all intent and purpose were practically pounding the engine to pieces.

FLANGE WEAR OF DRIVING TIRES.

This is ordinarily associated in fancy with divisions of railroads having more than the average degrees of curvature, but the observations of the writer serve to dismiss this view as entirely erroneous. For instance, on the A. B. C. railroad it was found that the straightest division indicated the most cut flanges, while on another, exceedingly crooked, the flange wear remained merely at the average for what might be expected in the instance of heavy power. The cause of flange wear is improper spacing of the driving wheel tires, helped along by excessive lateral motion in engine truck boxes.

So many errors in the correct setting of tires have been noted on so many railroads, that, in the consideration of flange wear, improper spacing of tires must be assigned as the primary cause. Improper spacing in this sense is intended to mean carelessness in securing the exact measurement from one time to another, on the same pair of wheels, as laid down in the standard practises.

There are certain recognized standards for the spacing of the tires, for instance on 2-8-0 type, 53⅜ inch for Nos. 2 and 3 pair, and 53¼ inch for Nos. 1 and 4 pair, and the mere matter of living up to these standards, and even disregarding all contributing causes of flange wear, will in most cases reduce this trouble fifty per cent. This will appear an extravagant statement, as it would imply that a disregard of standards exists in all cases where tire troubles are in evidence. It should not, however, be so construed, but rather that there is a laxity in the shops in this important regard which escapes the management, who, with the knowledge that prints and instructions exist, thoroughly covering the matter in detail, are often lulled into a false security, under the impression that the mere presence of these in the tire gang conveys the assurance that they will be lived up to.

From records covering the close inspection of hundreds of engines during the past few years, wherever flange cutting has been in evidence the writer notes some remarkable variations from standard practises. One instance in particular should be mentioned, that of a 2-8-0 engine, 17 feet rigid wheel base, with all flanged tires, which actually had the front tires spaced 53¾ inch, and, quoting from the report: "⅝ inch wider than spacing for best results, and ⅜ inch wider than any recognized spacing." This is, of course, a somewhat extreme case, but it actually occurred on a well handled railroad, simply because the confidence in the tire foreman was misplaced.

Another engine of the same class had tires spaced as follows: No. 1, 53 7/16 inch; No. 2, 53 7/16 inch; No. 3, 53½ inch; No. 4, 53¼ inch. Still another example: No. 1, 53⅜ inch; No. 2, 53½ inch; No. 3, 53½ inch, and No. 4, 53 5/16 inch. In this arrangement the first pair of wheels in each engine had tires at least ¼ inch further apart than any recognized spacing; Nos. 2 and 3, ⅛ inch further apart than any practise, and No. 4, ⅛ inch in excess of the best practise. Another engine had front driving tires 5/16 inch too far apart, and another ⅜ inch. Each of these engines showed pronounced flange cutting. A pleasing contrast was afforded, however, in still another engine of the same type. This had Nos. 1 and 4 set at 53⅛ inch, and Nos. 2 and 3 at 53⅜ inch, and exhibited no flange wear whatever, or even rubbing, although the tires had been on five months and the engine had made the same, if not more, mileage than the others mentioned.

The above examples, while occurring on one road, are merely illustrative of what has been encountered on several others, and every one of these roads had shop practise cards and blue prints covering all necessary information to secure correct tire-setting. On one of these, which ran through a mountain country, with all the popular causes present against the longevity of flanges, such vigorous action was taken on the portrayal of these conditions that seventy-five per cent. of this abnormal flange wear was eliminated within the ensuing six months. The measures which brought about such a gratifying result were: (1) Replacing the measuring sticks of wood, and other makeshifts which had been in use in the wheel gang, by solid gauges with hardened points, one set for each class of engine, and by impressing on those concerned that they must wake up to the importance of the matter; (2) the issue of clear prints for shop use, giving the standard practise for setting tires on all engines, and (3) temporarily at least providing an inspector to gauge every set of tires after mounting in the wheel shop, and certify on a regular form to the correctness of the setting.

It has been said that the insistence on attention to the details in the wheel shop will eliminate fifty per cent. of flange troubles, and the writer firmly believes this to be true. The correction of contributing causes must devolve upon the care and vigilance exercised in the roundhouse after the locomotive has been put in service.

It is of utmost importance along these lines to keep within reasonable limits the inevitable accumulation of lateral motion in the engine truck wheels. An excess of this, which should be taken to mean anything greater than ½ inch total, is without question the principal contributing cause to driving tire flange wear. Excessive lateral motion in the engine truck results in the leading driving tires being most affected by high degree curves; in other words, the engine truck does not receive its share of the impact of the curve. When this lateral motion is combined with excessive wide spacing of the front driving tires there could be no other logical result than excessive flange wear or flange cutting.

Ideal conditions, however, will not have been reached until all wheel centers are standardized, and all tires bored with a lip. The tire then applied to the center so far as the lip will allow is properly spaced in relation to its mate on the opposite wheel. This is said, of course, with a full realization that should the lip tire plan be adopted, a long time must elapse before the good results which will certainly follow can fully materialize. This is because wheel centers on old engines are frequently at variance with standards; many are too far apart, while some are too close, and in consequence, facing the outside of the rim to bring the standard lip tire to its proper position would have to vary with each individual case. The soundness of the lip tire idea, however, will be readily appreciated by those familiar with the hurry and handicap imposed when tires are changed in roundhouses. The chances for error in the setting, which are frequently in evidence under such conditions, would entirely disappear, as the tire could only be applied to the center as far as its lip would allow.

BROKEN FRAMES IN SERVICE.

There is little of value to comment on in connection with this particular feature, as it is generally conceded that fractured frames should not be continued in service, but they are so continued, although it is not believed that the management is cognizant of such procedure. Some broken frames, of course, are placed immediately on the hospital list through the location of the break, for example, immediately back of the cylinder, in the tongue piece or front rail. There are many other fractures, however, which do not incapacitate the locomotive for the time being, and in ninety per cent. of instances they are winked at by the local supervision, and the engine allowed to run until such time permits, if it ever comes around, when the engine can be best spared for repairs.

The great trouble in this connection is that the roundhouse foreman, ever busy in meeting the exact requirements of his daily schedule, can scarcely be expected to exhibit the finesse of feeling to look far into the future of a single locomotive, especially when that locomotive is apparently doing its work, even if the frame is in two pieces. It is a matter for the master mechanic to know, and to know personally, through a system of reports which admit of no evasion, the condition of each and every frame under his jurisdiction. By taking this matter into his own hands, and having his force understand that he handles it, the roundhouse foreman in his turn will exploit what it now looks very much as though he was covering up.

Briefly broken frames should not be run for this reason: the break attests to the presence of an abnormal stress, and after the fracture occurs these strains must be transmitted to and borne by some other part of the frame which never was designed to sustain this double duty. Thus metal fatigue is set up in parts far removed from the original defect, and may serve to explain the many failures which occur in other parts of the frame after the primary break has been welded up and the engine returned to service.

There is another point in connection with broken frames, and worthy of deep reflection, viz., their welding when these fractures occur. The writer has little faith in the stability of a thermit weld, and less in one made by oil, on a "V" piece set into the break. Without recourse to argument he believes that oil welds are only brazed at best, and that although they may apparently hold are no less than a menace to security. One of these latter is recalled, made with great care in one of the principal shops of the A. B. C. railroad, famed for just this class of work, which let go in the one hundred and forty miles to the next division. Its cross section showed only thirty per cent. of the metal united in the weld.

Although conceded somewhat radical the recommendation is offered that when the break occurs the engine be retired from service and the frame removed to be honestly welded up under the hammer. This convincingly disposes of the matter, whereas conjecture must predominate when other makeshifts are employed.

It is unfortunate that a thorough study has not been made of the efficacy of the various welds. It might easily be done, too, by stamping in a clean place on the frame adjacent to the weld a certain symbol to indicate the nature of the weld. For instance, the letter "T" would indicate thermit; "O," oil weld, and "F," an honest forge weld. Then when any of these failed a good record would be inaugurated for the future, and from which many more binding inferences might be drawn than in the present hap-hazard procedure.

Lost Motion in Rod Brasses and Connections.

The design of these parts is generally adequate, and a thorough review, in this instance at all events, seems to show that when in an abnormally bad condition the latter results from the driving box wedges being even worse. With enough bang between the shoes and wedge faces to almost permit the driving boxes to turn over in the jaws at each revolution of the wheels it is not likely that perfection will evince in the much less massive rod bearings. When the wedges are all the way up, and no longer hold the boxes, the double duty is imposed on the rod brasses and knuckle pins to not only turn the wheels, but keep the wheels properly aligned as well: something, of course, impossible for them to do for very long.

Of course, the writer encountered instances in plenty where the wedges were in good condition, and the rod brasses were poor, but this simply spelled neglect, and does not alter the above general conclusion.

It looks absurd, when the matter is properly understood, and there is no mystery about it, to see a roundhouse foreman give a machinist a work slip to take down the intricate and cumbersome middle connection side rod brass for the purpose of reducing it, while right behind that same wheel the driving box wedge is jammed against the top of the frame, and no longer serving the purpose for which intended. Common sense would certainly dictate to line that wedge to-day, and reduce the brass to-morrow, then the latter will be in the nature of an enduring job, but vice versa it will have to be reduced again next week, unless it is the intention to allow it to knock the pin off, or break itself to bits.

The writer is advised that in a certain roundhouse 200 rod brasses were applied in a single month, and this was pointed to with pride, as an illustration of the care which they were taking of their rods, but if the condition of the shoes and wedges on those engines when inspected was representative of the period referred to this heavy application need not be considered unusual. If this labor had been spent in part in lining down wedges, and keeping them adjusted where they belonged, probably one hundred of these new brasses, not to mention innumerable knuckle pins, might have been saved. Only the intelligent handling of the shoe and wedge proposition will ever result in adequate maintenance of rod brasses and their connections. It is practically killing two birds with one stone.

The above consideration of five points embodies what the writer believes to be the secret of prolonging the life of an engine between shoppings, and just the way they are viewed and lived up to is the gauge of success in this line for any division. It was not the intention in the foregoing to dilate on self-evident truths, but merely to present what the inspector offered to the A. B. C. railroad in solution, or at least as a move in the right direction. The minor elements of deterioration, the organization employed to combat them, and the effect of personality on locomotive maintenance will be reviewed in the next and final article in this series.

TEST OF LOCOMOTIVE DRIVING WHEELS.

ACCURATE MEASURING OF THE DEFORMATION OF DRIVING WHEELS DUE TO THE CENTRIFUGAL ACTION OF THE COUNTERBALANCE AND THE THRUST AGAINST THE FLANGE WHEN CURVING. ALSO THE AREA OF CONTACT BETWEEN THE WHEEL AND RAIL.

E. L. Hancock.

The investigation of the deformation of two locomotive driving wheels due to the various forces acting upon them is outlined below. The object of the test on wheel No. 1 was to determine the deformation due to the centrifugal force of the counterbalance, and to determine, if possible, whether or not this deformation was sufficient to account in part for the presence of flat spots on drive wheels just in front of the counterbalance. It was thought that this centrifugal force might be great enough to cause the wheel to roll in a slightly elliptical form. To determine whether or not such deformation was possible, it was decided that tests should be made in a testing machine. In addition to these, tests were made to determine the deformation while under load and the area of contact of the wheel with a 90-pound rail. The wheel was furnished by the American Locomotive Company. The center was of cast steel, the whole wheel weighing 3,500 pounds and with dimensions shown in Fig. 1.

The tests were made in a Riehle testing machine of 300,000 pounds capacity. For the tension tests the wheel was arranged as shown in Fig. 2, so disposed as to admit of the application of tension along a diameter through the center of the crank pin and counterbalance. In order to prevent unusual distortion due to the hole in the center of the wheel, a cast iron plug was driven in from the convex side. Rods were attached along the vertical and horizontal diameters to projecting pieces of steel soldered to the tread and projecting out over the flange. A

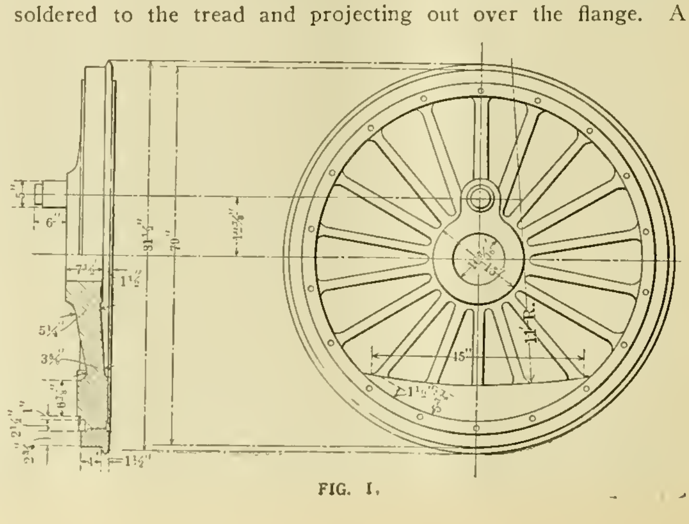


FIG. 1.

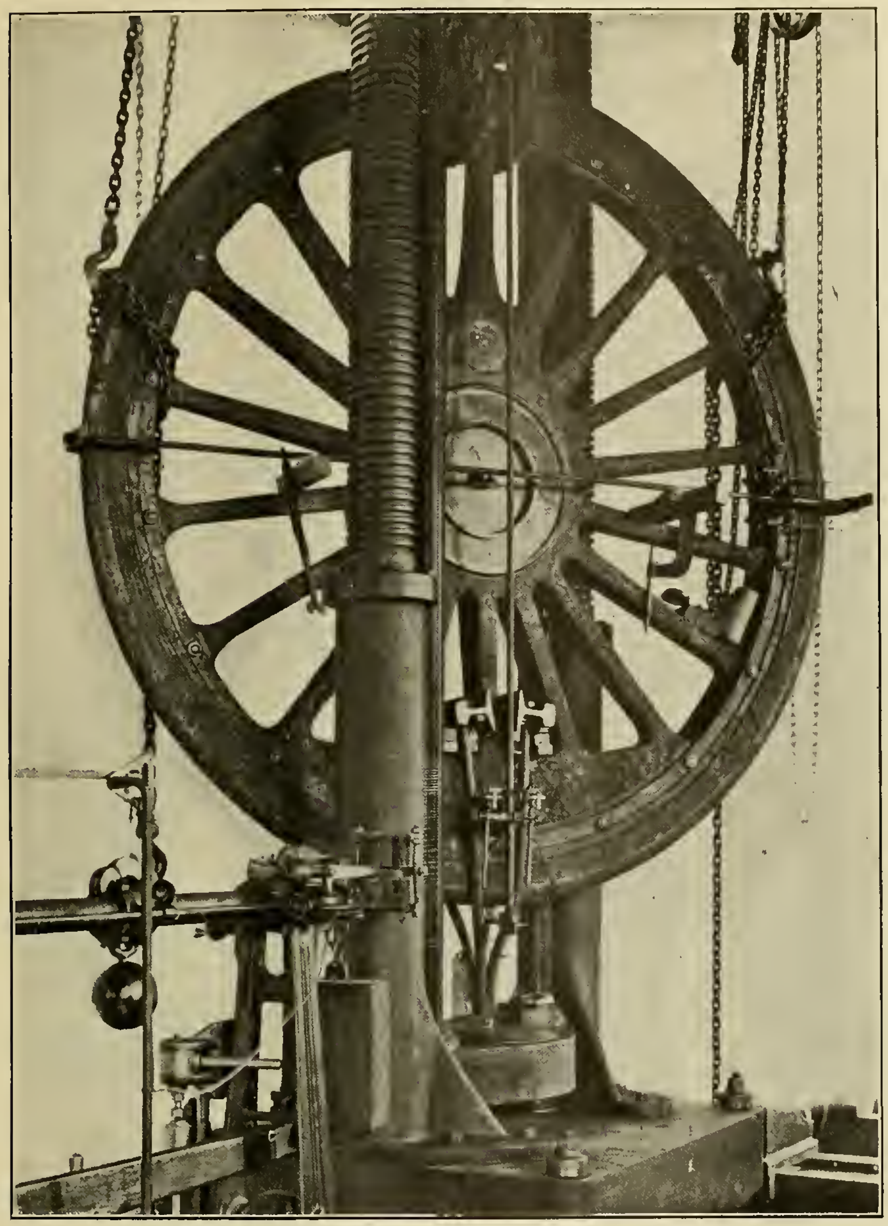


FIG. 2.—DRIVING WHEEL IN RIEHLE TESTING MACHINE.

short piece of tubing fitted over one end of the rod in such a manner as to admit of extension along the diameter. Extenso meters were placed on each of these rods, one end being on the piece of tubing and the other on the rod. In this way when the diameter of the wheel changed, the rod moved in the tube and this movement was measured by means of the extensometers. The extensometers were of the Riehle type, measuring to 1/10000 of an inch. Great care was used in getting the pieces soldered to the tread and in adjusting all parts connected with the measuring apparatus.

To guard against accident, two chains, shown in Fig. 2, were kept in place. These chains were loose during the tests.

Loads were applied in increments of 3,000 pounds, and the resulting deformation measured along the two diameters. The results are shown by curves (1) and (3), Fig. 3. These curves represent the average of three tests. In each case it was found upon releasing the load that there was no set in the wheel.

A second series of tests were made by pulling from the hub and counterbalance. The arrangement was the same as that shown in Fig. 2, except that the large chain at the top, instead of pulling from the rim, was extended around the hub. The results of these tests are shown by curves (2) and (4), Fig. 3. In this case, also, no set was observed when the load was released.

The force of 60,000 pounds applied, for an unbalanced mass in the counterbalance of 800 pounds weight, corresponds to a speed of 250 miles per hour.

For a speed of 100 miles per hour the estimated pull would be about 10,000 pounds. If such a force acts along the diameter through the crank pin, it is obvious that the wheel should be stiff enough along a diameter at right angles to prevent any appreciable deformation of the wheel. From curve (1), Fig. 3, it is seen that the deformation of the diameter due to a pull of 10,000 pounds is about .002 inches, an amount that certainly might be neglected. From tests made by Professor Goss it is evident that the wheel lifts off of the rail at times. If we assume that this lifting force may be due to the centrifugal force, say 25,000 pounds, the change of diameter is only .0045 inches. Even the change in diameter caused by the pull of 60,000 pounds is so slight as to have no practical significance. It does not seem probable that the total deformation was not measured by the method employed since the test was repeated many times with almost identical results. Further evidence of the accuracy of the method of measurement is seen in the return to the same zero each time after the load had been removed.

The next series of tests was designed to show the deformation due to the load by measuring the area of contact between the wheel and rail. For this purpose the apparatus was changed somewhat, the cast iron plug being driven through the hub until it projected equally on each side, so that the projecting ends might rest upon columns supported on the base of the testing machine. (See Fig. 4.) A section of a new 90-pound rail was clamped in an inverted position to the under side of the moving head of the machine in such a way that when lowered, it gave contact with the tread of the wheel. The load was then applied by lowering the moving head. In other words, the rail was pressed down upon the wheel instead of the wheel being pressed upon the rail.

Areas of contact were measured at different points on the tread, keeping the rail always in the same position relative to the flange of the wheel. These areas were taken by inserting a piece of carbon paper and a piece of white tissue paper between

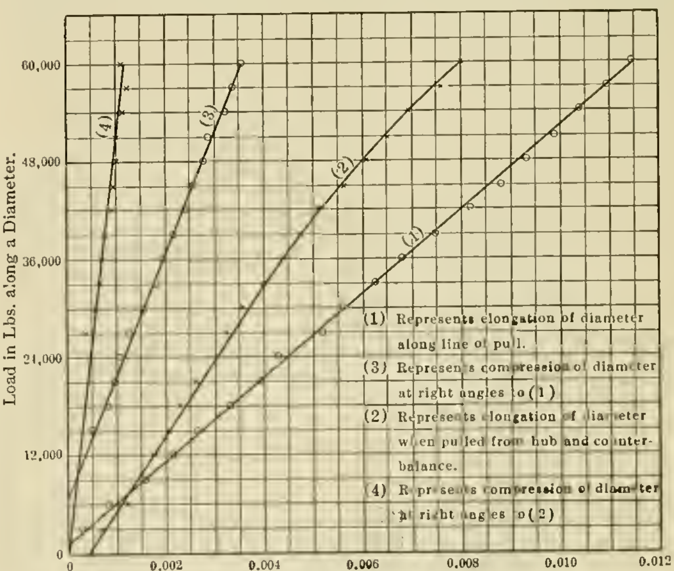


FIG. 3.

the wheel and rail. After the load was applied the print of the area of contact was left upon the paper where it was measured by means of a planimeter. Areas were measured at points along the tread indicated by Fig. 5, and the results are shown by the curves. Loads were applied in increments of 5,000 pounds up to 25,000 pounds. The results of these tests seem to show that there is less deformation of the wheel when the rail is in the vicinity of the crank pin than for any other position and a greater deformation when the contact is 90 degrees from that position. In other words, that the wheel is stiffer along a diameter through the crank pin than along any other diameter.

To extend the tests made on wheel No. 1 and to check their validity, tests were made on another wheel which we shall designate as wheel No. 2. This second wheel was much heavier in all its parts than the first, weighing with hub and crank pin 5,700 pounds. It is shown in section in Fig. 6. The tension test was omitted in this case, since the deformations obtained from the tension tests of wheel No. 1 were so small. The wheel was mounted as shown in Fig. 4, and areas of contact with a 75-pound rail were taken at different points on the tread. Possible changes of length of the diameter at right angles to that of the contact point were measured by extensometers arranged as in the case of the tension tests on wheel No. 1, Fig. 2. This wheel was also furnished by the American Locomotive Company; both wheel and rail were new. Areas were taken by means of carbon and tissue paper as before, and the chains shown in Fig. 4 were loose during the tests. Areas of contact were taken for various loads up to 80,000 pounds. These areas are shown in the following table:

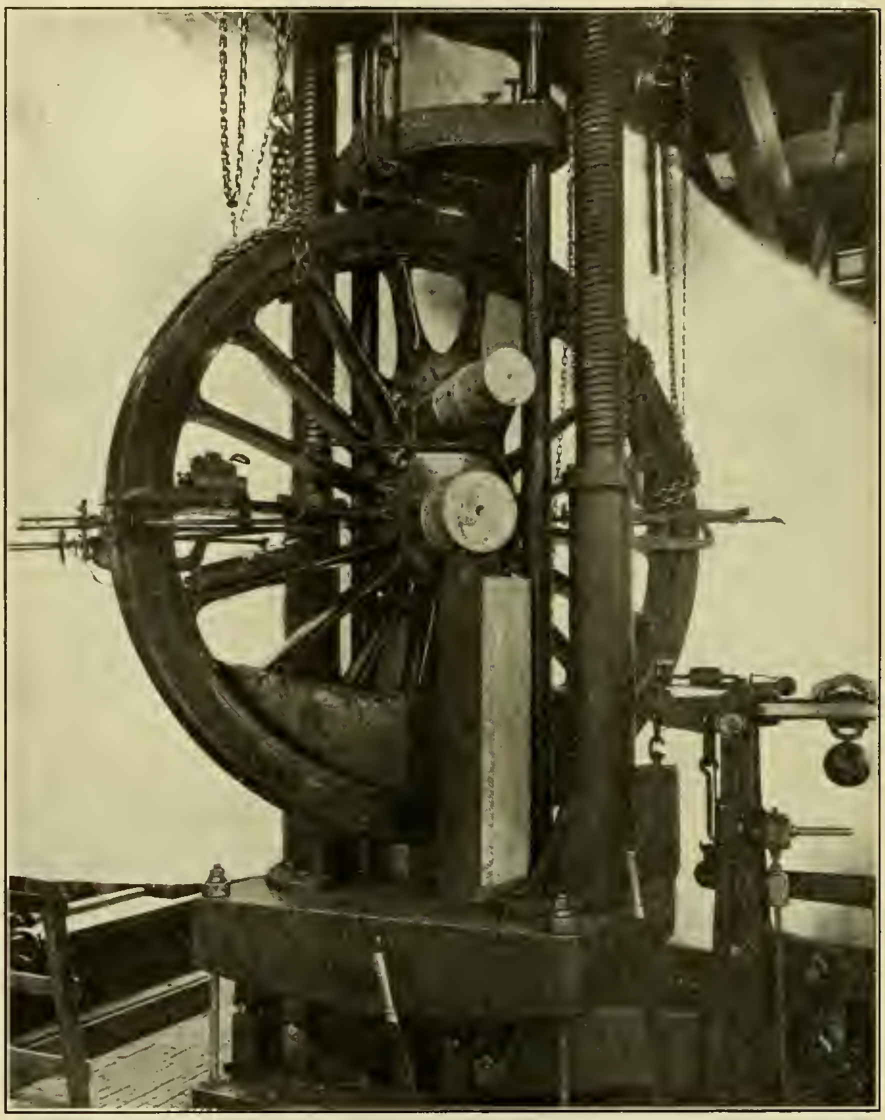


FIG. 4.—TESTING FOR AREA OF CONTACT BETWEEN WHEEL AND RAIL.

Load in pounds.	Area midway crank pin and counterbalance in sq. in.	Area counterbalance, sq. in.	Area crank pin, sq. in.	Average area, sq. in.
10,000	.36	.33	.35	.346
20,000	.48	.52	.51	.503
30,000	.57	.61	.63	.603
40,000	.68	.73	.74	.716
50,000	.75	.75	.81	.77
60,000	.80	.85	.92	.856
70,000	.91	.95	.99	.95
80,000	1.00	1.01	1.02	1.01

Here the areas taken midway between the crank pin and counterbalance are smaller than the others, indicating less deformation of the tread. Those taken over the center of the counterbalance were smaller for this wheel than those over the crank pin. As above noted, an effort was made to detect any change of diameter of the wheel caused by the application of the load. The extensometers, which measured to 1/10000 of an inch, gave no indication of any change. Both Riehle and Johnson extensometers were used. Since there was no change in diameter the increased area obtained at the crank pin must be accounted for by a local bending of the tire and rim. This view is further confirmed by the fact that in this wheel the areas over the crank pin were greater than those over the counterbalance, while in the case of wheel No. 1 the reverse is true. By referring to Fig. 2 and Fig 4 it is seen that the area over the crank pin in 4 came between two spokes while in 2 it was directly over a spoke. The area midway between the crank pin and counterbalance in 4

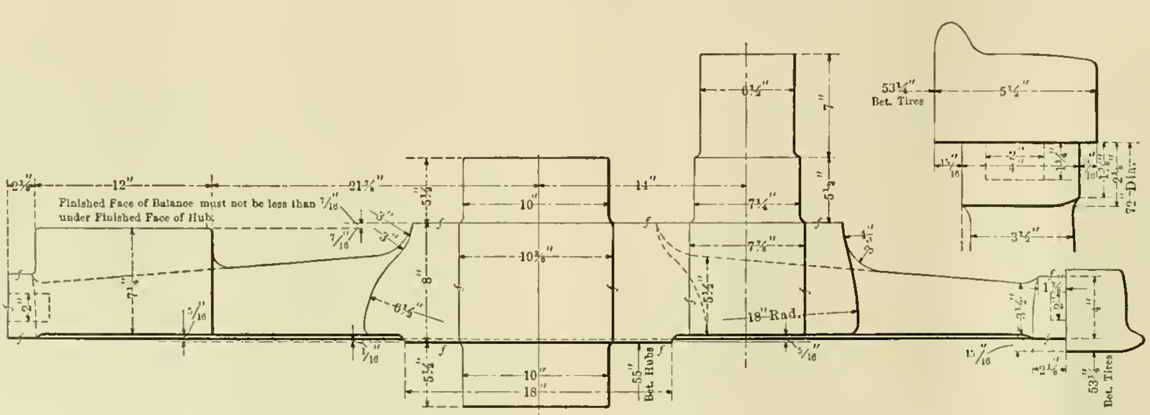


FIG. 6.

was over a spoke, while in 2 it was between two spokes. No further tests were made to determine whether or not this view regarding local bending as the sole cause of the difference of areas of contact for different points on the tread, was correct. It seems, however, a fair way of explaining the facts observed.

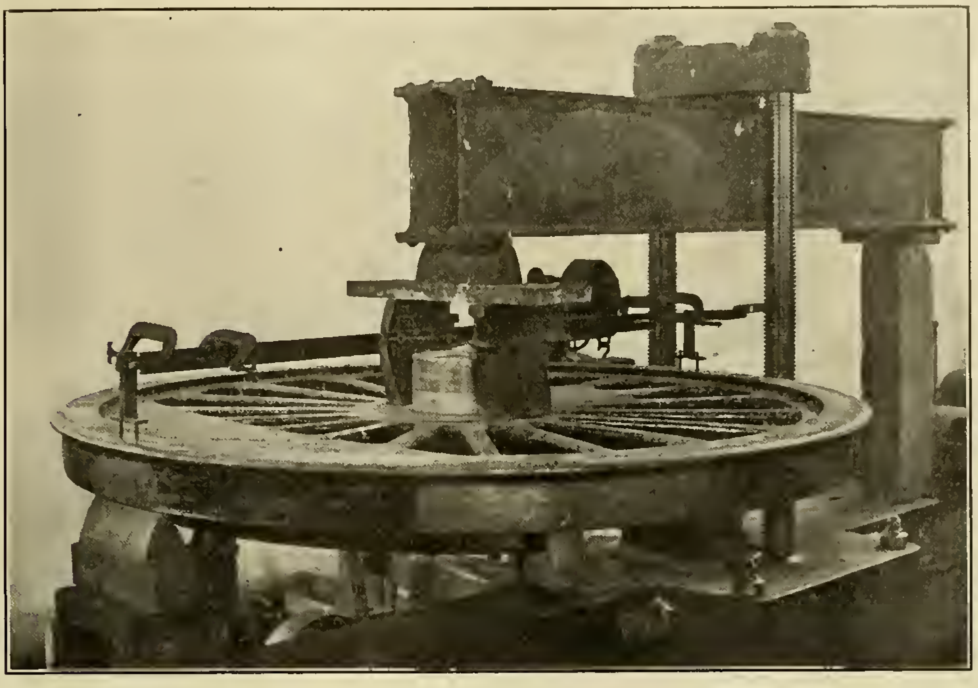


FIG. 7.—WHEEL MOUNTED FOR TESTING EFFECT OF FLANGE PRESSURE.

This wheel, No. 2, was also tested for deflection due to transverse loads, viz.: such loads as would be caused by flange pressure against the rail. For this test the wheel was mounted on

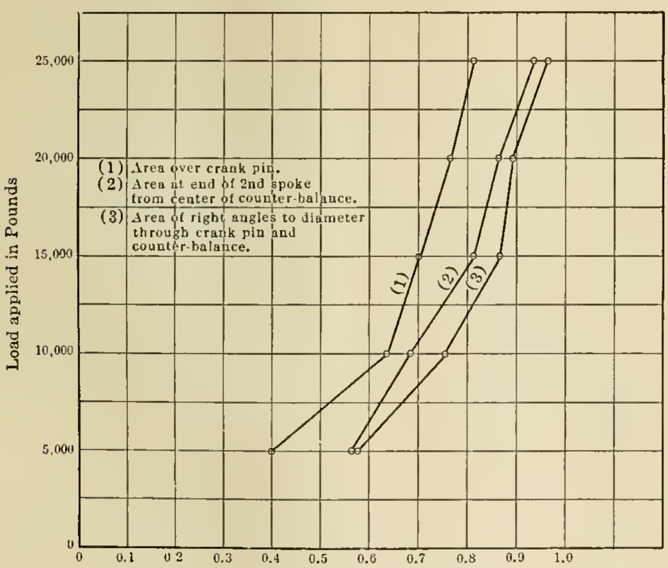


FIG. 5.

one arm of a 200,000 pound Riehle testing machine, as shown in Fig. 7. The weight of the wheel was counterbalanced on the other arm of the machine and loads applied at the center as shown in the figure. Deflections were measured in thousandths of an inch for loads of 1,000 pounds up to 40,000 pounds. Several tests were made with the wheel in the position shown, and the average of these tests is shown by curve (1), Fig. 8. Then the wheel was turned and supported with the knife edges at the extremities of a diameter through the edge of the counterbalance. Curve (2), Fig. 8, shows the average of these tests. Finally the wheel was supported with the supports at the extremities of a diameter at right angles to the position shown in Fig. 7. The results of these last tests are shown in curve (3), Fig. 8. It is seen from these curves that the deflection for the various loads is about the same for the positions (1) and (3) and somewhat less for position (2). This means that the wheel is stiffer when the flange pressure is at the edge of the counterbalance than for the other positions.

It is to be noted that the wheel was not supported at the flange as in service, but by supports 77 inches apart. The results of the tests show that a formula for deflection in which the deflection varies as the cube of the diameter, holds approximately in this case. Considering the wheel supported by the flange, this gives the deflection for (1), for the 40,000 pounds pressure, as .098 inches instead of .091 inches, as read from the curve.

It is appreciated that supporting the wheel as was done and applying the load at the center does not exactly reproduce the conditions of service, but it is believed that it approximates them as near as may be done in a static testing machine. It is believed that this flange pressure of 40,000 pounds is greater than any so far obtained in track tests for lateral pressure. In the *Railroad Gazette*, Sept. 20, 1907, Mr. Geo. L. Fowler reports, for a consolidation locomotive weighing 174,300 pounds and running at 30.6 m.p.h. on a 4 degree 25 min. curve a maximum drive wheel pressure of 13,000 pounds. It is to be noticed, however, in this case that the superelevation of the outer rail was 3.875 inches,

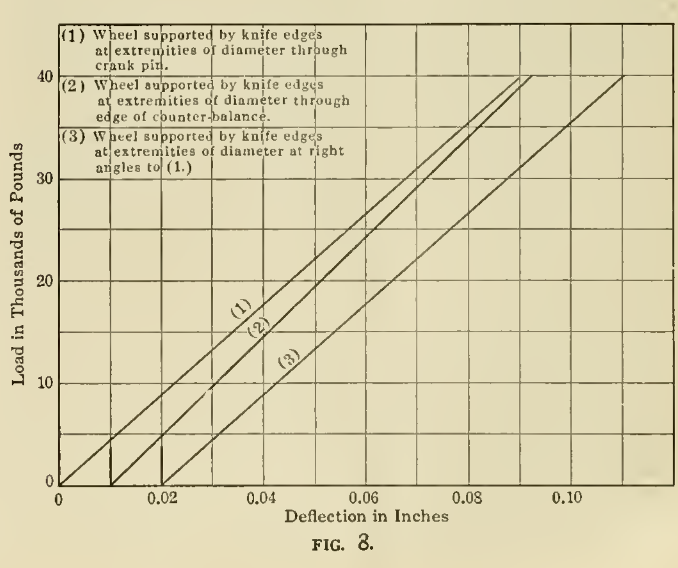
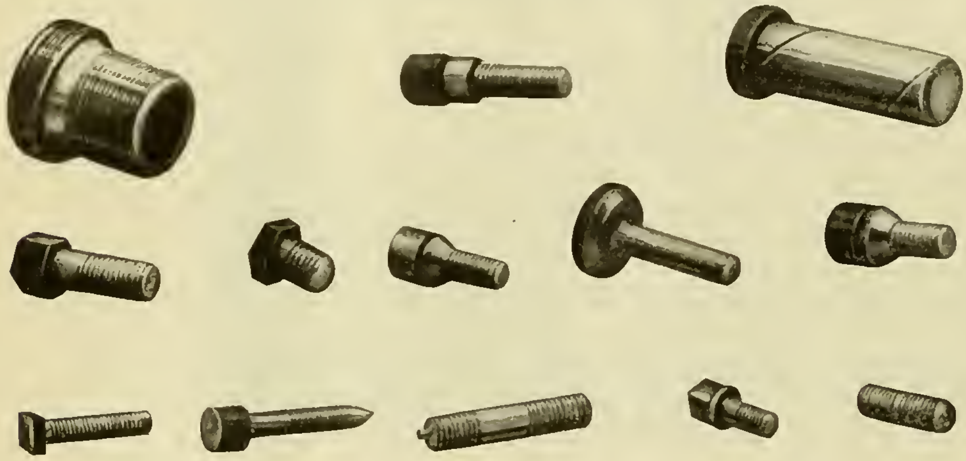


FIG. 8.

corresponding to a speed of 36.6 m.p.h. It is certain that at speeds exceeding this limit the flange pressure would be considerably increased. The rather large pressure of 40,000 pounds allows for extraordinary conditions.

AUTOMATIC MACHINES FOR LOCOMOTIVE PARTS.

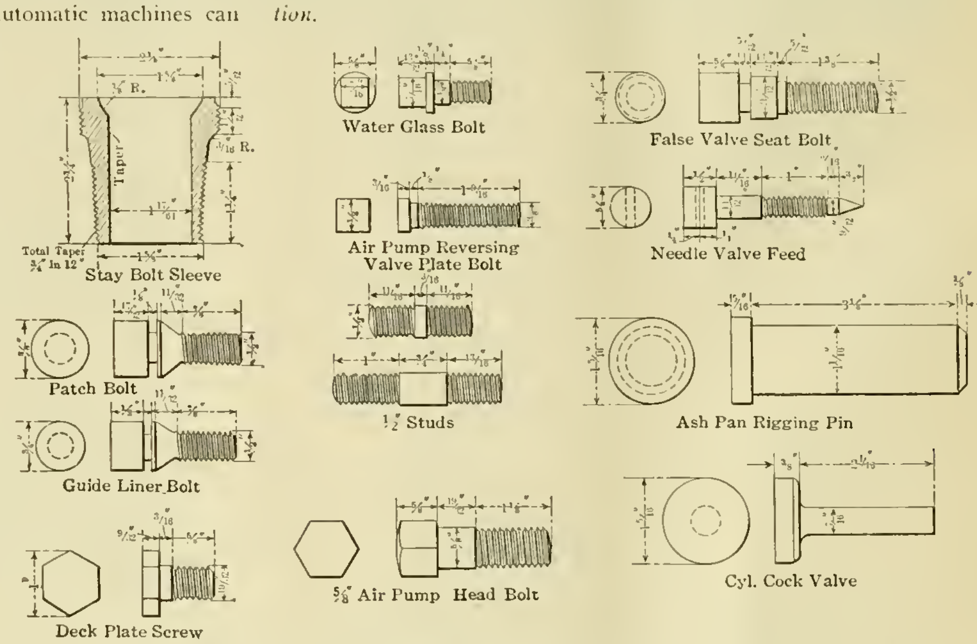
In almost all modern railroad shops at the present time there is an increasing tendency to the use of turret lathes for the manufacture of small parts such as screws, studs, etc. The degree of efficiency attained by these tools of course is very good, but in most cases for certain small parts to be made constantly in large quantities the output can be increased to a remarkable extent by the use of automatic machines.



LOCOMOTIVE PARTS MADE ON AN AUTOMATIC MACHINE.

The use of automatic screw machines in railroad work is somewhat of a departure from the usual practice, but in a modern shop where the work is centralized there is no reason why these machines should not be used more extensively. While a good turret lathe may possibly do the same work somewhat faster,—the cost of production with the use of automatic machines can be reduced about *four* or *five* times because one man with a helper can easily operate about ten of these machines.

Four automatic screw machines have been in service for a number of years at one of the large modern shops and are giving very satisfactory results. Two of these were manufactured by the Cleveland Auto. Machinery Co., and the max. size of the work is 2¼ x 6 in. and 2¼ x 4 in. respectively. The other two are the No. 54 and No. 56 Acme multiple spindle machines, with four heads, manufactured by the National Acme Mfg. Co., of Cincinnati, Ohio, one of them being equipped with tools to make 1⅞ in. adjustable staybolt sleeves, and the other is used chiefly for small studs. One of the Cleveland machines is used chiefly for turning out pins such as driver brake pins, etc., while the other is used for small miscellaneous work.



DETAILS GIVING DIMENSIONS OF LOCOMOTIVE PARTS MADE ON AN AUTOMATIC MACHINE.

One man operates all these tools at present, but with a helper he will be able to very easily operate twice that number when the requirements of the whole shop shall warrant the installation of additional tools of this kind.

The four tools are placed in a group with five brass turret lathes; and eight other iron lathes, which require a motor of about 30 h.p. capacity, although the group is at present driven by a Bullock Electric Co. 18 h.p., 900 r.p.m., shunt motor, which is overloaded about 100 per cent.

The great variety and also the quality of work turned out by these automatic machines may be somewhat of a surprise to many railroad shop men, but when we consider that this work is done at one-quarter the cost of the same work on a turret lathe it seems truly remarkable. The cost could be still further reduced if all these parts were made in a centralized shop for several divisions so that more machines could be installed. Some of the work which these machines are turning out is shown in the illustration.

Red Seal engine oil is used as a cutting lubricant and gives very good results, the oil being of course used over and over again.

The large pin shown is used on ash pan rigging, requires about *eight* min. to finish as shown, or, in other words the output is 75 pins per 10 hr. day on a Cleveland machine. The same machine turns out 180 studs ⅝ x 1 in., or about 210 studs ½ x 1 in., in 10 hrs., while the Acme No. 54 multiple spindle machine turns out about 400 ½ x 1 in. studs in a 10 hr. day. The capacity of the Acme No. 56 is about 75 flexible staybolt sleeves in 10 hrs., or 8 min. per sleeve. The sleeves are all completed on this machine except balling out the top to receive the spherical bolt head.

The supervision required is practically nothing and while they do not turn out work much faster than some good turret lathes, it is evident that it can be done more economically and also with more speed when two or more additional machines can be set up for the same work in case of emergency to obtain an increased output.

We have less trouble with boiler failures since we began using a hot water washout system. Our boilermakers were on a strike for six weeks and we did not have a delay on account of a boiler failure.—*C. L. Dickert at the General Foremen's Convention.*

The Pennsylvania established a new record during the month of March in overhauling engines at the Altoona shops. In all, 205 locomotives were received at the shops and repaired. Of this number, 35 were given what is known as heavy running repairs, while the remaining 170 were given repairs to various broken parts.

The East River tunnel of the Pennsylvania R. R. at New York will be in operation about August 15.

FROM THE AMERICAN E

OPERATION

Name of road	…HERN Ill. Cen.	MIDDLE WESTERN C. B. & Q.	C. & N. W.	C. R. I. & P.	M. P.	U. P.	S. L. & S. F.	SOUTH WESTERN S. P.	A. T. & S. F.	NORTH WESTERN N. P.	C. M. & St. P.	G. N.	Can. Pac.
Miles of track	4,378	9,022	7,632	7,526	6,489	3,299	4,740	5,718	5,573	5,672	7,286	6,923	10,106
Number of locomotives owned.	1,238	1,676	1,452	1,361	1,053	656	892	1,305	1,612	1,347	1,423	1,065	1,478
Number of freight cars owned	67,255	54,780	59,760	40,583	44,414	15,450	30,182	25,933	45,045	42,208	55,488	42,920	50,434
MILEAGE, ETC.													
Miles per passenger locomotive	49,000	39,000	52,000	36,000	51,000	53,000	49,000	49,000	27,000	40,000	58,000	39,000	33,000
Miles per freight locomotive..	20,000	19,000	22,000	20,000	20,000	18,000	17,000	15,000	19,000	15,000	26,500	13,000	22,000
Miles per total locomotive....	29,000	27,000	33,000	27,000	30,000	29,000	26,000	26,000	25,000	24,000	37,000	23,000	31,000
Average weight on drivers per	56	58	47	58	59	68	56	60	64	67	47	67	59
Average tractive effort per loco	24,000	23,000	22,000	26,000	30,000	30,000	25,000	27,000	30,000	30,000	20,000	30,000	26,000
COST OF MAINTAINING EQU													
Cost of maintaining equipment	31	30	16	19	22	25.5	15	30	29	25	17	25.5	24
Cost of maintaining equipment	38	39	21	23	27.5	32	22.5	42	36	32.5	18	34	30
Cost of maintaining equipment	1.85	2.05	1.60	1.85	1.70	1.50	1.80	2.40	2.20	1.50	1.45	1 25	1.80
Cost of maintaining equipment	12.75	12 80	7.40	7.30	7.30	8.30	7.20	11.20	9.80	8.20	8.40	6.90	9.30
Cost of maintaining equipment	270	255	175	165	185	185	160	250	225	185	185	155	205
Percentage of maintenance of e	28	24.5	18	18	21	21.5	19	22	24.5	21	18	18	22
Percentage of maintenance of e	21	17	12	12.4	15.2	10.2	12.2	13	15	11.5	12	11.5	15.4
COST OF MAINTAINING LOC													
Cost of maintaining locomotives	9.2	7.4	5.8	8.4	9.8	11.2	9.2	11.5	9.8	7.2	5.4	5.4	10
Cost of maintaining locomotive	2,700	2,000	1,900	2,300	2,900	3,250	2,400	3,100	2,500	1,750	2,000	1,800	3,100
Cost of maintaining locomotives	.56	.50	.58	.82	.75	.65	.91	.94	.75	.44	.45	.40	.75
Cost of maintaining locomotives	11	8.5	8.8	9.2	9.8	10.8	9.6	11.5	8.2	6	9.8	6	12
Cost of maintaining locomotives	3.80	3.20	2.70	3.30	3.20	3.70	3.70	4.35	3.30	2.40	2.70	2.15	3.90
Cost of maintaining locomotives	82.	63.	62.	74.	81.	82.	82.	99.	77.	55.	57.	59.	86
Percentage of maintenance of lo	9	6	6.5	8.2	9	9.4	9.6	8.5	8 2	6.2	6	6	9.2
Percentage of maintenance of lo	30	25	36	45	44	44.5	50.8	39	34	30	32	32	42
Percentage of maintenance of lo	6.4	4.2	4.3	5.6	6.6	4.6	6.2	5.1	5.1	3.4	3.8	3.6	6.5
MAINTENANCE OF FREIGHT													
Maintenance of freight cars per	92.	64.	40.	68.	58.	104.	50.	110.	110.	42.	70.	34.	58
Percentage of cost of maintainin	15	6	5.5	6.2	7.5	6.8	6	6.6	8.8	4.5	8	4.5	5.5
Percentage of cost of maintainin	16	6.2	5.4	6.8	7.5	4.6	5.8	6.2	8	3 8	7.3	3.7	6
COST OF MAINTAINING SHO													
Shop machinery and tools per 1,	7.	6.50	3.00	4.40	4.70	8.80	3.20	6.40	6.10	3.50	5.50	3.20	7.50
Shop machinery and tools per lo	200.	175.	95.	120.	140.	250.	85.	170.	155.	85.	205.	70.	230
Shop machinery and tools per 1,0	4.2	4.4	2.8	4.2	3.6	5.2	3.2	5.2	4.8	2 2	4 6	1.7	5.5
Shop machinery and tools per wo	28.5	28	13	17	16	28	13	24	20	12	27.5	8	28.5
Shop machinery and tools per roa	6.20	5.60	3.10	3.80	4.00	6.40	2.90	5.50	4.90	2.60	5.90	1.90	6.30
Percentage of shop machinery an	7.3	8.8	5	5.2	4 9	7.8	3.5	5.5	6.3	4.6	10.2	4	7.4
Percentage of shop machinery an	2.3	2.2	1.8	2.4	2.1	3.5	1.8	2.2	2.1	1.4	3.2	1.3	3.1
Percentage of shop machinery an	.47	.37	.21	.30	.32	.36	.22	.28	.32	.16	.39	.14	.48
Percentage of shop machinery an	.66	.52	.32	.42	.44	.72	.34	.46	.52	.30	.60	.24	.68
COST OF LOCOMOTIVE FUEL.													
Cost of fuel for locomotives per	9.8	13.2	13.0	14.5	11.6	16.0	10.8	15.6	12.7	20.5	12.5	19.5	16.8
Cost of fuel for locomotives per	2,800	3,550	4,350	4,000	3,450	4,550	2,800	4,150	3,200	4,900	4,700	4,300	5,300
Percentage of cost of locomotive	9.4	10.8	14.5	14.0	11.0	13.4	11.2	11.5	10 2	17.0	13.8	14.3	15.5
Pounds of freight locomotive fuel	450	625	780	760	690	690	850	590	670	570	675	440	490
Revenue tons of freight per freig	350	380	260	260	275	425	225	400	300	430	240	500	300
1,000 revenue ton miles per freig	7,000	7,200	5,800	5,400	5,900	8,000	4,000	5,000	5,800	6,000	7,000	6,600	7,000
Revenue tons of freight per loade	18	17	14 5	15	16.5	16	17	17	15	18	14.5	20	17
Percentage of revenue tons of fre	49	50	40	45	50	45	47	45	49	53	42	62	56
Density of traffic—1,000 revenue	1,300	750	700	550	700	1,000	500	700	700	850	700	700	650

† Work unit = tractive effort in pou
* Road unit = weight on drivers in

The data for this table is take
the Interstate Commerce Commiss ince from
it is realized that inaccurate conclu , as com-
larly in connection with comparin ous. The
It is well understood by those in every
many factors which must be taken der which
with the idea of determining the r -miles on
appreciated, for instance, that a ro ly to the
pared in items of locomotive main
with a system operating through le at this is
hich was

due to some unusual condition, as, for instance, the cost of fuel on any basis may have r up because of unusual weather conditions, a coal strike or some other labor trouble. T cost of shop tools and machinery may be very high, due to installation of a new shop w: a complete new equipment, and so on.

It has been attempted to group the different roads that traverse approximately the sa character of country, but in doing this justice has not been possible in every case. Roa which lie in approximately the same district often traverse an entirely different charac of country and are subject to the conditions illustrated above. It is believed that with th few warnings our readers will not be misled in using this table, which it is planned to ha a regular yearly feature in the future.

From the AMERICAN ENGINEER AND RAILROAD JOURNAL, June, 1910.

STATISTICS OF MOTIVE POWER DEPARTMENT OPERATION

FOR YEAR ENDING JUNE 30, 1909

	NEW ENGLAND				EASTERN							CENTRAL AND SOUTHERN					MIDDLE WESTERN					SOUTH WESTERN		NORTH WESTERN			
Name of road	N. Y., N. H. & H.	B. & M.	P. R. R.	Penn. Co.	N. Y. C.	B. & O.	Erie	L. S. & M. S.	P. & R.	L. V.	D., L. & W.	P. C. C. St. L.	Sou. Ry.	L. & N.	Ill. Cen.	C. B. & Q.	C. & N. W.	C. R. I. & P.	M. P.	U. P.	S. L. & S. F.	S. P.	A. T. & S. F.	N. P.	C. M. & St. P.	G. N.	Can. Pac.
Miles of track	2,045	2,288	5,307	1,342	2,629	3,446	2,114	1,520	1,492	1,393	957	1,472	7,055	4,349	4,378	9,022	7,632	7,526	6,489	3,299	4,740	5,718	5,573	5,672	7,286	6,923	10,106
Number of locomotives owned	1,187	1,073	4,094	1,006	1,894	1,729	1,417	921	1,061	873	751	632	1,523	887	1,238	1,676	1,452	1,361	1,053	656	892	1,305	1,612	1,347	1,423	1,065	1,478
Number of freight cars owned	33,751	27,039	115,817	37,624	66,556	81,753	52,214	40,887	42,810	41,533	28,292	23,633	52,371	41,010	67,255	54,780	59,760	40,583	44,414	15,450	30,182	25,933	45,045	42,208	55,488	42,920	50,434
MILEAGE, ETC.																											
Miles per passenger locomotive	29,000	29,000	37,000	50,000	37,000	46,000	28,000	43,000	32,000	33,000	34,000	47,000	37,000	53,000	49,000	39,000	52,000	36,000	51,000	53,000	49,000	49,000	27,000	40,000	58,000	39,000	33,000
Miles per freight locomotive	16,000	24,000	15,000	17,000	19,000	21,000	18,000	21,000	16,000	19,000	21,000	24,000	17,000	32,000	20,000	19,000	22,000	20,000	20,000	18,000	17,000	15,000	19,000	15,000	26,500	13,000	22,000
Miles per total locomotive	24,000	27,000	24,000	27,000	28,000	29,000	20,000	28,000	23,000	23,000	26,000	32,000	25,000	35,000	29,000	27,000	33,000	27,000	30,000	29,000	26,000	26,000	25,000	24,000	37,000	23,000	31,000
Average weight on drivers per locomotive in tons	47	46	70	66	67	65	67	71	57	63	64	64	59	59	56	58	47	59	59	68	56	60	64	67	47	67	59
Average tractive effort per locomotive, pounds	22,000	20,000	32,000	30,000	30,000	31,000	28,000	31,000	27,000	27,000	26,000	28,000	29,000	27,000	24,000	23,000	22,000	26,000	30,000	30,000	25,000	27,000	30,000	30,000	20,000	30,000	26,000
COST OF MAINTAINING EQUIPMENT.																											
Cost of maintaining equipment per locomotive mile—cents	20	16	32.5	24	23	21	31	24	32	29.5	17.5	25	21	25.5	31	30	16	19	22	25.5	15	30	29	25	17	25.5	24
Cost of maintaining equipment per train mile—cents	26	22.5	49	34	32.5	29	42	36	49	44.5	35.5	33	26	30	38	39	21	23	27.5	32	22.5	42	36	32.5	18	34	30
Cost of maintaining equipment per 1,000 revenue ton miles—dollars	3.15	2.20	1.50	1.30	1.80	1.20	1.65	1.20	1.95	1.35	1.35	1.75	2.25	1.85	1.85	2.05	1.60	1.85	1.70	1.50	1.80	2.40	2.20	1.50	1.45	1.25	1.80
Cost of maintaining equipment per work unit†—dollars	9.10	8.20	10.12	8.00	7.80	6.60	11.20	7.80	12.00	10.80	9.20	9.10	7.20	9.25	12.75	12.80	7.40	7.30	7.30	8.30	7.20	11.20	9.60	8.20	8.40	6.90	9.30
Cost of maintaining equipment per road unit*—dollars	215	175	235	180	175	160	230	170	280	230	185	200	180	210	270	255	175	165	185	185	160	250	225	185	165	155	205
Percentage of maintenance of equipment to operating expenses	16	16.5	28	25	24.5	23	30	23.5	32	28	25	25.5	23	26	28	24.5	18	18	21	21.5	19	22	24.5	21	18	18	22
Percentage of maintenance of equipment to gross earnings	11	12	19.4	15.9	17.1	15.4	20	15	19.2	17.4	13.6	17.6	15.8	17.2	21	17	12	12.4	15.2	10.2	12.2	13	15	11.5	12	11.5	15.4
COST OF MAINTAINING LOCOMOTIVES																											
Cost of maintaining locomotives per locomotive mile—cents	7.2	5.4	10.2	8.2	6.8	7.2	13	6.2	9.8	10	6.2	8	7	8.2	9.2	7.4	5.8	8.4	9.8	11.2	9.2	11.5	9.8	7.2	5.4	5.4	10
Cost of maintaining locomotives per locomotive—dollars	1,750	1,500	2,500	2,250	1,900	2,100	2,650	1,700	2,250	2,250	1,700	2,550	1,800	2,800	2,700	2,000	1,900	2,300	2,900	3,250	2,400	3,100	2,500	1,750	2,000	1,800	3,100
Cost of maintaining locomotives per 1,000 revenue ton miles—dollars	1.15	75	48	44	53	42	.70	30	53	.45	36	.55	.75	.59	56	50	58	82	.75	65	.91	.94	.75	44	45	40	75
Cost of maintaining locomotives per pound of tractive effort—cents	8	7.5	7.8	7.4	6.2	6.8	9.6	5.4	8.5	8.4	6.4	9.4	6.2	10.6	11	8.5	6.8	9.2	9.8	10.8	9.6	11.5	8.2	6	9.8	6	12
Cost of maintaining locomotives per work unit†—dollars	3.30	2.75	3.50	2.80	2.25	2.35	4.80	1.95	3.65	3.65	2.45	2.90	2.45	3.00	3.80	3.20	2.70	3.30	3.20	3.70	3.70	4.35	3.30	2.40	2.70	2.15	3.90
Cost of maintaining locomotives per road unit*—dollars	77	60	74	64	50.	55.	100	42	86.	78	49	63	60.	68	82	63	62.	74	81	82	82	99.	77	55.	57.	59	86.
Percentage of maintenance of locomotives to operating expenses	6	5.8	8.8	8.4	7	8	12.8	6	9.6	9.6	6.5	8	7.8	8.6	9	6	6.5	8.2	9	9.4	9.6	8.5	8.2	6.2	6	6	9.2
Percentage of maintenance of locomotives to maintenance of equipment	36.5	34	31.5	34	29	35	42.5	25	30	34	26	32	33	32	30	25	36	45	44	44.5	50.8	39	34	30	32	32	42
Percentage of maintenance of locomotives to gross earnings	4	4.1	6.1	5.4	5	5.4	4.5	3.7	5.8	6	3.6	5.5	5.2	5.5	6.4	4.2	4.3	5.6	6.6	4.6	6.2	5.1	5.1	3.4	3.6	3.6	6.5
MAINTENANCE OF FREIGHT CARS.																											
Maintenance of freight cars per freight car owned—dollars	32.	50	60	48	92.	54	50.	72	60.	50.	51	96	50.	62	92	64.	40.	68	58.	104.	50.	110	110.	42.	70.	34	58
Percentage of cost of maintaining freight cars to operating expenses	3.2	4.4	8.4	9.2	9.8	8.8	8.8	11	14	10	7.5	9.8	7.4	8.5	15	6	5.5	6.2	7.5	6.8	6	6.6	8.8	4.5	5	4.5	5.5
Percentage of cost of maintaining freight cars to freight earnings	4.2	5.5	8.2	8	12	7.8	8	11	11	7.5	5.6	10	7.8	7.8	16	6.2	5.4	6.8	7.5	4.6	5.8	6.2	8	3.8	7.3	3.7	6
COST OF MAINTAINING SHOP MACHINERY AND TOOLS.																											
Shop machinery and tools per 1,000 locomotive miles—dollars	9	1.60	6.20	5.10	5.	6.	7.25	6.60	6.	7.	6.60	6.80	3.50	4.20	7	6.50	3.00	4.40	4.70	8.80	3.20	6.40	6.10	3.50	5.50	3.20	7.50
Shop machinery and tools per locomotive—dollars	220	45.	150.	140	140.	176.	150.	185	140.	160	170.	220.	85	145.	200	175.	95.	120.	140.	250.	85.	170.	155	85.	205.	70.	230
Shop machinery and tools per 1,000 revenue ton miles—cents	14.2	2.2	3.0	2.8	4.0	3.4	4.0	3.2	3.6	3.2	3.8	4.8	3.8	3.0	4.2	4.4	2.8	4.2	3.6	5.2	3.2	5.2	4.8	2.2	4.6	1.7	5.5
Shop machinery and tools per work unit†—cents	41.5	8.	19.5	17.5	17.	19.5	27.	22	22.5	26.	25	24.5	12.	15.5	25.5	28	13	17	16	28	13	24	20	12	27.5	8	28.5
Shop machinery and tools per road unit*—dollars	9.70	1.80	4.50	3.90	3.70	4.70	5.60	4.70	5.40	5.50	5.10	5.40	2.90	3.50	6.20	5.60	3.10	3.80	4.00	6.40	2.90	5.50	4.90	2.60	5.90	1.90	6.30
Percentage of shop machinery and tools to maintenance of locomotives	12.4	2.8	6.	6.2	7.2	8.2	5.6	11	6.1	7	10.5	8.6	5.	5.1	7.3	8.8	5	5.2	4.9	7.8	3.5	5.5	6.3	4.6	10.2	4	7.4
Percentage of shop machinery and tools to maintenance of equipment	4.5	1	1.9	2.1	2.1	2.9	2.4	2.7	1.9	2.4	2.7	2.7	1.6	1.6	2.3	2.2	1.8	2.4	2.1	3.5	1.8	2.2	2.1	1.4	3.2	1.3	3.1
Percentage of shop machinery and tools to gross earnings	.49	.12	37	.34	.37	.45	.47	40	36	42	38	47	.26	28	47	.37	.21	.30	.32	.36	.22	28	.32	.16	.39	.14	48
Percentage of shop machinery and tools to operating expenses	.74	.17	.54	52	.52	.66	.72	64	59	68	68	68	.38	44	66	.52	.32	42	44	.72	.34	46	52	30	60	24	.68
COST OF LOCOMOTIVE FUEL.																											
Cost of fuel for locomotives per locomotive mile—cents	17.4	14.6	10.2	9.0	10.7	8.2	11.5	11.6	11.2	14.0	10.5	8.8	9.0	8.4	9.8	13.2	13.0	14.5	11.6	16.0	10.8	15.6	12.7	20.5	12.5	19.5	16.8
Cost of fuel for locomotives per locomotive—dollars	4,200	3,900	2,450	2,450	3,000	2,400	2,400	3,200	2,650	3,200	2,600	2,850	2,250	2,900	2,800	3,550	4,350	4,000	3,450	4,550	2,800	4,150	3,200	4,900	4,700	4,300	5,300
Percentage of cost of locomotive fuel to operating expenses	14.4	15	8.6	9.1	11.2	9.1	11.2	11.3	11.1	13.6	11.0	8.8	9.8	8.8	9.4	10.8	14.5	14.0	11.0	13.4	11.2	11.5	10.2	17.0	13.8	14.3	15.5
Pounds of freight locomotive fuel per 1,000 revenue ton miles	640	660	420	390	530	640	570	370	550	530	460	590	1,000	700	450	625	780	760	690	690	850	590	670	570	675	440	490
Revenue tons of freight per freight train	270	240	640	470	410	430	470	610	450	530	510	340	210	260	350	380	260	260	275	425	225	400	300	430	240	500	300
1,000 revenue ton miles per freight locomotive	4,000	5,000	7,600	7,600	6,600	[illegible],000	7,500	11,400	6,500	8,800	7,800	7,800	3,600	8,800	7,000	7,200	5,800	5,400	5,900	8,000	4,000	5,000	5,800	6,000	7,000	6,000	7,000
Revenue tons of freight per loaded freight car	14	14	27	24	16.5	22	21	19	23	23	22	18	14	19.5	18	17	14.5	15	16.5	16	17	17	15	18	14.5	20	17
Percentage of revenue tons of freight per loaded car to average capacity	45	51	62	60	45	60	56	50	70	64	70	41	44	57	49	50	40	45	50	45	47	45	49	53	42	62	56
Density of traffic—1,000 revenue ton miles per mile of road	900	900	4,400	3,700	2,300	2,300	2,700	3,400	3,800	3,050	3,750	2,250	500	950	1,300	750	700	550	700	1,000	500	700	700	850	700	700	650

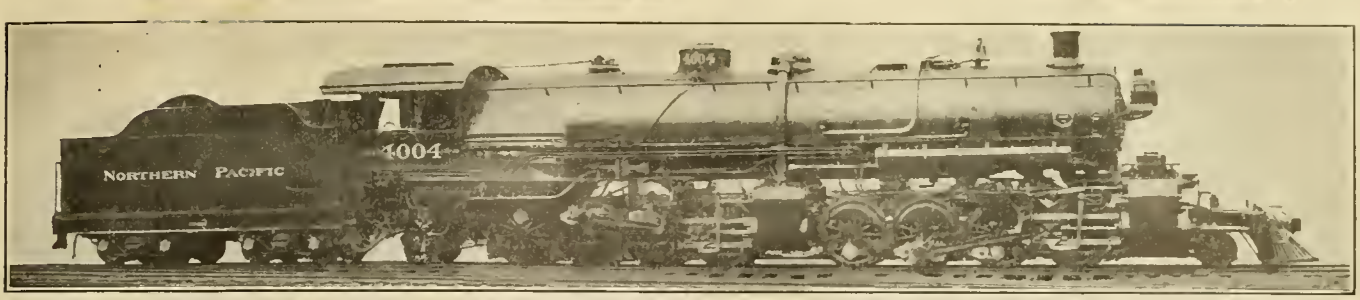
† Work unit = tractive effort in pounds × locomotive miles ÷ 1,000,000.
* Road unit = weight on drivers in pounds × locomotive miles ÷ 100,000,000.

The data for this table is taken from the reports submitted by the various railroads to the Interstate Commerce Commission for the year ending June 30, 1909. In presenting this, it is realized that inaccurate conclusions may possibly be drawn from these figures, particularly in connection with comparing one road with another.

It is well understood by those who are familiar with railroad statistics that there are many factors which must be taken into consideration in comparing one system with another with the idea of determining the relative efficiency of the managements. It will be readily appreciated, for instance, that a road operating in a mountainous territory cannot be compared in items of locomotive maintenance, fuel consumption, or shop tools and machinery with a system operating through level country. This fact is well illustrated by taking two sections of the Atchison, Topeka & Santa Fe Railroad, one including the distance from Chicago to Wellington, Kans., a distance of over 700 miles, that is practically level, as compared with the district from Belen, N. M., to the coast, which is very mountainous. The practices and scheme of operation of these two sections are practically identical in every way and the locomotives employed are particularly well suited to the conditions under which they operate, but the cost of locomotive repairs and fuel per thousand gross ton-miles on the first district is 26.4 cents, while on the second district it is 42 cents, due entirely to the character of the country they traverse.

Another feature which should be remembered in this connection is the fact that this is for one year's operation only and that an unsatisfactory result may be shown which was due to some unusual condition, as, for instance, the cost of fuel on any basis may have run up because of unusual weather conditions, a coal strike or some other labor trouble. The cost of shop tools and machinery may be very high, due to installation of a new shop with a complete new equipment, and so on.

It has been attempted to group the different roads that traverse approximately the same character of country, but in doing this justice has not been possible in every case. Roads which lie in approximately the same district often traverse an entirely different character of country and are subject to the conditions illustrated above. It is believed that with these few warnings our readers will not be misled in using this table, which it is planned to have a regular yearly feature in the future.



POWERFUL MALLET LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY.

HEAVY ARTICULATED LOCOMOTIVES.

Northern Pacific Railway.

In 1907 the Northern Pacific Ry. received from the Baldwin Locomotive Works sixteen Mallet locomotives of the 2-6-6-2 type, having a total weight of 351,600 pounds with 313,550 pounds on driving wheels. The performance of these engines in heavy pushing and road service has been eminently satisfactory, and the same company has recently received eleven additional Mallet locomotives from the same works. Five of these engines have the 2-8-8-2 wheel arrangement and are similar in many respects to Southern Pacific locomotives 4000 and 4001, built in the spring of 1909.* The remaining six have the 2-6-6-2 wheel arrangement and are of practically the same capacity as the light Mallets (class L-2) operating on the Great Northern,† although many changes have been made in the details.

2-8-8-2 Type.—The Southern Pacific locomotives previously referred to are equipped for oil burning, while the new Northern Pacific engines are coal burners. The firebox has been redesigned, its width being increased from 78¼ to 96 inches, thus enlarging the grate area from 68.4 to 84 square feet. The crown is stayed by radial bolts, and is supported at the forward end from two tee bars hung on expansion links.

The grate is composed of finger bars rocking in four sections, with two drop plates in front. Two sections of bars are placed on each side, and are supported on the center line by a longitudinal bearer of cast steel. The ash pan has three hoppers, with cast iron sliding bottoms of substantial construction.

As in the Southern Pacific locomotives, the boiler is separable with a feed water heater in the front section. The smokebox contains a Baldwin reheater, to which steam is conveyed from the high pressure cylinders by horizontal pipes placed under the running boards. The arrangement of the frames, articulated connection and sliding bearings calls for no special comment. The steam distribution to all the cylinders is controlled by inside admission piston valves, 15 inches in diameter. The low pressure pistons have cast steel bodies and the rods are extended through the front cylinder heads.

2-6-6-2 Type.—These engines are not of the heaviest class, and are specially adapted to road service on moderate grades. The details of construction include a number of interesting features.

The steam distribution to all the cylinders is controlled by inside admission piston valves, 13 inches in diameter. As no reheater is used, the high pressure exhaust is conveyed to the low pressure cylinders by a single pipe, placed on the center line of the locomotive. The center of the ball joint at the back end of the receiver pipe coincides with the center of the articulated frame connection, so that the length of the receiver pipe is practically constant under all circumstances. . The cast steel radius bar connecting the front and rear frames is placed below the receiver pipe, and has a forward extension which braces the frames transversely above the main driving pedestals. The hinge-pin is 6 inches in diameter, and is seated in a cast steel cross-tie which spans the lower rails of the rear frames between the high-pressure cylinders. This arrangement provides a strong and simple frame joint, and leaves room for the receiver pipe as well as for the reach rod connecting the high and low-pressure reverse shafts. This reach rod is placed on the center line, and passes through a slot in the high-pressure cylinder saddle.

As in the case of the 2-8-8-2 engines, the low-pressure piston rods are extended through the front heads and all the cylinders are fitted with Sheedy circulating valves as used by the Associated Lines.

The boiler is of the straight topped, radial stay type, and contains 4,014 square feet of heating surface and 53.4 square feet of grate area. The separable joint and feed water heater are omitted. The boiler is supported on the front frames by a single bearer placed between the second and third pairs of driving wheels. The front bearer carries the controlling springs, and normally has a clearance of ½ in. between the upper and lower castings.

The tenders of both classes have 8,000 gallon tanks and are carried on arch-bar trucks with cast-steel bolsters. The wheels are steel tired with cast steel plate centers. The tender frames used with the 2-6-6-2 type locomotives are composed of 12-inch channels, while 13-inch channels are used in the tender frames for the heavier engines.

The principal dimensions of both classes of locomotives are given in the following table:

GENERAL DATA.		
Type	2-8-8-2	2-6-6-2
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Service	Freight	Freight
Fuel	Bit. Coal	Bit. Coal
Tractive effort	94,640 lbs.	57,760 lbs.
Weight in working order	437,950 lbs.	305,150 lbs.
Weight on drivers	403,800 lbs.	262,350 lbs.
Weight on leading truck	18,750 lbs.	21,500 lbs.
Weight on trailing truck	15,400 lbs.	21,300 lbs.
Weight of engine and tender in working order	590,000 lbs.	455,000 lbs.
Wheel base, driving	39 ft. 4 in.	28 ft. 11 in.
Wheel base, total	56 ft. 7 in.	43 ft. 7 in.
Wheel base, engine and tender	82 ft. 7¾ in.	70 ft. 10½ in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.26	4.56
Total weight ÷ tractive effort	4.63	5.30
Tractive effort × diam. drivers ÷ heating surface	840.00	785.00
Total heating surface ÷ grate area	76.00	75.00
Firebox heating surface ÷ total heating surface, %	3.90	4.94
Weight on drivers ÷ total heating surface	62.50	65.10
Total weight ÷ total heating surface	68.00	76.00
Volume equiv. simple cylinders, cu. ft.	28.84	17.10
Total heating surface ÷ vol. equiv. cylinders	223.00	235.00
Grate area ÷ vol. equiv. cylinders	2.91	3.12
CYLINDERS.		
Kind	Compound	Compound
Diameter	26 and 40 in.	20 and 31 in.
Stroke	30 in.	30 in.
VALVES.		
Kind	Piston	Piston
Diameter	15 in.	13 in.
WHEELS.		
Driving, diameter over tires	57 in.	55 in.
Driving, thickness of tires	3½ in.	3½ in.
Driving journals, main, diameter and length	11 x 12 in.	9½ x 12 in.
Driving journals, others, diameter and length	10 x 12 in.	9½ x 12 in.
Engine truck wheels, diameter	30 in.	30 in.
Engine truck journals	6 x 12 in.	6 x 12 in.
Trailing truck wheels, diameter	30 in.	30 in.
Trailing truck, journals	6 x 12 in.	6 x 12 in.
BOILER.		
Style	Straight	Straight
Working pressure	200 lbs.	210 lbs.
Outside diameter of first ring	84 in.	74 in.
Firebox, length and width	126 x 96 in.	116⅛ x 66¼ in.
Firebox plates, thickness	⅜ and ½ in.	⅜ and ½ in.
Firebox, water space	5 in.	5 in.
Tubes, number and outside diameter	401—2¼ in.	310—2¼ in.
Tubes, length	21 ft.	21 ft.
Heating surface, tubes	4,941 sq. ft.	3,816 sq. ft.
Heating surface, firebox	252 sq. ft	198 sq. ft.
Heating surface, total evaporating	5,193 sq. ft.	4,014 sq. ft.
Feedheater heating surface	1,220 sq. ft.	——
Reheater heating surface	655 sq. ft.	——
Heating surface, total	6,413 sq. ft.	4,014 sq. ft.
Grate area	84 sq. ft.	53.4 sq. ft.
TENDER.		
Wheels, diameter	33 in.	33 in.
Journals, diameter and length	5½ x 10 in.	5½ x 10 in.
Water capacity	8,000 gals.	8,000 gals.
Coal capacity	13 tons	13 tons

* See American Engineer, May, 1909, pp. 181.
† See American Engineer, June, 1907, pp. 213.

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CONTENTS

SHOP ARRANGEMENT.

A serious mistake in the relative location and arrangement of the various buildings making up a railroad shop plant will be the cause of unnecessary expense and trouble for years to come with no possible hope of correction. While it is recognized that the conditions and requirements of each large shop differ in some respects, it would seem as if there are enough features common to all plants to make it possible to develop principles governing the relative location of buildings of such a shop. We have been fortunate in being able to get Mr. Kingsley, who has made a long study of shop construction, to express his opinions in an article on page 201 of this issue. The principles he has presented are sound and will no doubt be found to cover practically every shop, impossible as that may seem to be at first thought.

FRONT END TESTS.

Among the many important tests that have been made on the Pennsylvania Railroad testing plant at Altoona during the past few years, were a series for developing a satisfactory self-clearing front end arrangement for the Atlantic type locomotives on that road. The importance of the proper design of this part of the locomotive has been recognized from the beginning and a number of years ago this journal, assisted by Purdue University and the American Railway Master Mechanics' Association, undertook an elaborate series of tests for the purpose of obtaining exact information on the factors that influence the results at this point. These tests were later extended and continued by the assistance and co-operation of a number of the railroad companies and some very valuable data is now available. These tests, however, were made on but two or three locomotives and while they established principles that are applicable within certain limits they were not able to develop formula of universal application. The tests at Altoona were not intended to cover the whole subject, but simply to develop an arrangement which, on this particular class of locomotive with the coal customarily used, would give a self-clearing front end combined with good steaming qualities at the rates of combustion ordinarily found in practice. Many arrangements were tried and those which proved most satisfactory are shown in the illustrations in the article on the opposite page. This article contains only a summary of the results and in the next issue we will give a complete account of the various tests that led to these results.

LOCOMOTIVE DESIGN.

The feature that stands out most prominently in a broad view of American locomotive design during the past decade, is undoubtedly simplicity. Practically every design in the past that has carried with it increased complication, no matter how excellent the results of tests or of service may have been in respect to economy, has been discontinued, after a short experience, in favor of the simplest and most rugged arrangement. Conditions in America seem to be such that we are unable to avail ourselves of the niceties of design that have proved so valuable in foreign countries.

This condition is a serious reflection upon American motive power departments and is one which it is to be hoped will very shortly be overcome. As a matter of fact the time has now arrived when we must use the largest locomotives and we must have increased complication to give greater economy, and we must take care of this power and keep it in first-class condition. The Mallet articulated compound locomotive equipped with feed water heaters, superheaters, reheaters and other complications, has arrived, is going to stay and the railroads cannot escape it. They must provide themselves with men and facilities to take care of this power as it is. Possibly it has arrived a little ahead of its time, but the fact remains that it has arrived, and the motive power departments of this country are about to undergo a test of efficiency and ability such as they have never been brought into contact with before.

RULES OF INTERCHANGE.

The rules of interchange probably represent the most valuable result of the formation of the Master Car Builders' Association. The value of these rules, however, is dependent very largely upon their universal acceptance and use by all members and it behooves the association as a whole to protect its own work by actively discouraging any violation or disregard of its rules. There has developed, during the past few years, a certain tendency among small local associations of railroad officers, joint car inspectors, etc., to disregard the M. C. B. rules of interchange and formulate their own code to suit "local conditions." Actions of this kind cannot be too strongly condemned. While it is quite possible that the rules of interchange in their present form are not the best that can be drawn up, the proper course is to have these rules revised rather than for each local point to use its own judgment as to whether they will be governed by them or not. The association has full power to change the rules and they can be altered so as to properly cover the conditions at practically every important point. It is, of course, true that conditions at all points are not the same and that the rules may not be flexible enough to do justice in all cases, but the remedy is not for the subscriber to calmly disregard the rules and make others to suit himself. It is easy to imagine the confusion that will surely result if each interchange point is to be governed by a different set of rules. As a matter of fact the result cannot help but be the practical paralyzation of through routing of freight.

The M. C. B. Association was formed primarily for the purpose of expediting the movement of freight cars between railroads and while its other activities, such as placing of responsibility of defects and the adoption of standards, are of great importance, they are secondary to this and it devolves upon the association to do all in its power to uphold its rules of interchange if it is to continue to hold the important place in the field of transportation that it now occupies.

This subject is of unusual importance just at this time when there is so much agitation in connection with the government regulation of railways. If railroads cannot obey their own rules what argument have they to advance against regulation by the government? It is only bodies that are capable of governing themselves that have a right to self-government and the railroad companies of this country cannot at the present time allow the impression to go forth that they are not able to formulate rules for interchange or otherwise, which are enforcible and will be obeyed.

We have reason to believe that this subject will be brought before the convention of the Master Car Builders' Association this year and trust that it will be given the attention its importance deserves and that some means will be found of satisfactorily solving the difficulty.

FRONT END TESTS

RESULTS OF A SERIES OF TESTS ON THE LOCOMOTIVE TESTING PLANT AT ALTOONA TO DETERMINE THE BEST ARRANGEMENT OF FRONT ENDS FOR PENNSYLVANIA ATLANTIC TYPE LOCOMOTIVES, CLASSES E2a AND E3a.

(Editor's Note.—*Below is given a general summary of the results of the tests made on locomotive front ends on the Pennsylvania Railroad testing plant at Altoona. In the following issue will be given a complete account of the various tests which led to these final conclusions.*)

A large number of tests of various kinds have been made on the testing plant with class E2a locomotive, No. 5266, which was equipped with a standard front end (Fig. 1) and while this was found to be a very good arrangement, so far as the steaming of the locomotive was concerned, it was not self-clearing and with some of the friable coals used the accumulation of cinders in the front end sometimes amounted to as much as 1,000 lbs. per hour. With gas coals the accumulation was not quite so serious, but often with these, 300 lbs. or more might be collected in an hour.

It was decided to experiment with various arrangements of front end apparatus to determine if it was possible to obtain one which would be equally successful with the standard for good steaming qualities, but which would also be self clearing. A number of tests were made on the testing plant with various arrangements, some of which showed themselves to be unsuccessful after a short time, and others proved successful in some respects, but unsuccessful in others.

After a number of preliminary runs of this kind it was found that three arrangements gave much better results than any of the others, and final tests were made to determine the relative value of these.

In estimating the comparative merits of the different devices tried, the following features were taken into consideration:

The quantity of water that could be evaporated as compared with the standard front end.

The evaporation per lb. of coal.

The general steaming of the locomotive.

The amount of cinders collected in the smoke box or discharged from the stack.

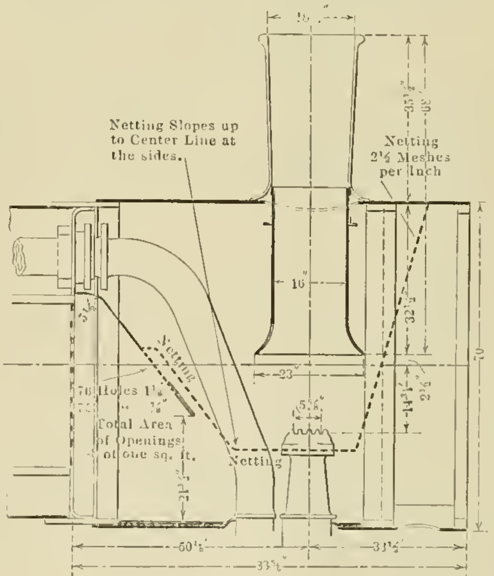


FIG. 1.

The tests made with these three arrangements were each of two hours' duration at 160 r. p. m., or 38 miles per hour. Good results were obtained with each arrangement (Figs. 2, 3 and 4), they all being perfectly self clearing except for a slight accumulation of cinders on the horizontal plate of the diaphragm.

In the following table some of the results of the tests with the standard (Fig. 1) front end and the arrangements shown in Figs. 2, 3 and 5, are given, these showing the results with two qualities of coal, the gas coal being the one normally used for passenger service.

R. P. M.	Cut-off Ins.	Throttle.	Duration of test. Hours.	Speed in miles per hour.	Front end arrangement. Figure number.	Cinders collected in smoke-box. Pounds per hour.	Sparks discharged from stack. Pounds per hour.	Boiler pressure. Pounds per square inch.	Evaporation, Dry Steam per sq. ft. of heating surface. Lbs. per hour.	Equivalent evaporation per sq. foot of heating surface. Pounds per hour.	Equivalent evaporation per pound of dry coal.	Coal fired.
160	27	Full	3	38	1	492	140	188.4	12.24	15.0	7.25	Friable
160	27	Full	1	38	2	10	529	199.9	12.25	14.76	7.28	"
160	27	Full	1	38	2	10	485	198.6	12.09	14.54	7.87	"
160	32	Full	2	38	1	326	341	201.2	15.04	18.24	7.01	Gas
160	32	Full	1	38	2	6	516	204.1	15.08	18.17	7.39	"
160	3	Full	2	38	3	0	303	199.5	14.80	17.89	8.65	"
200	25	Full	1	46	3	0	467	199.6	14.55	17.73	7.33	"
200	25	Full	1	46	4	0	293	202.7	14.38	17.63	8.15	"

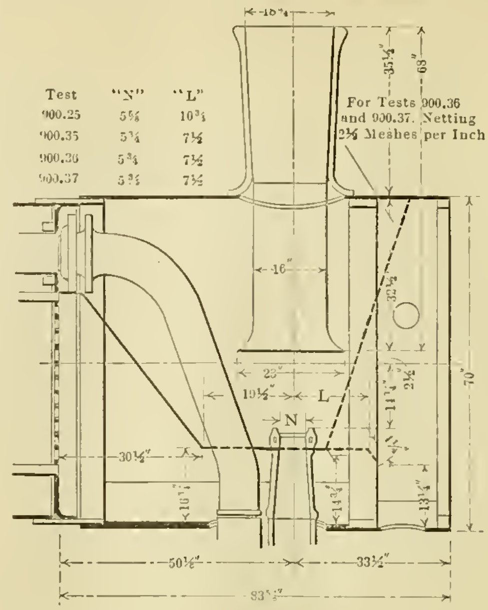


FIG. 2.

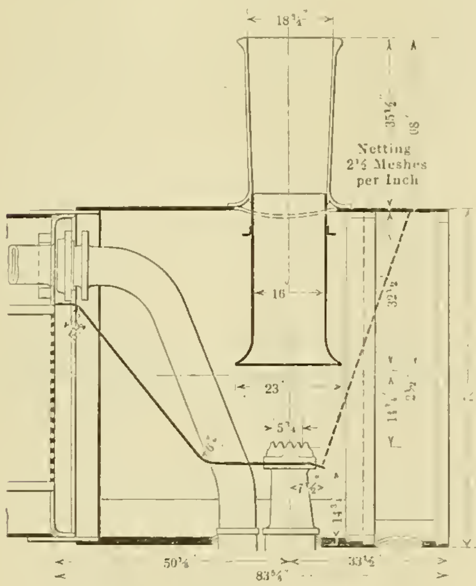


FIG. 3.

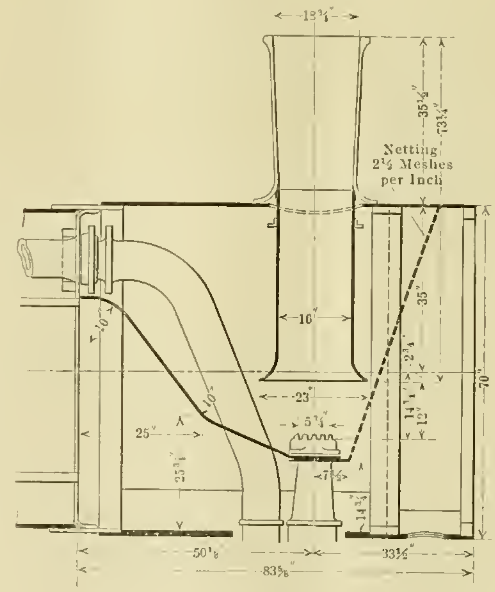


FIG. 4.

The conclusions drawn by the test department from all of the various tests are as follows:

1. A front end arrangement has been developed for the "E" class, which, while self-cleaning, maintains the boiler capacity or maximum evaporation fully equal to that with the standard front end arrangement.

2. With friable coals where large quantities of cinders are formed, the boiler capacity will be increased on long runs, on account of the smoke-box being kept clear of cinders which would obstruct the draft.

3. The front end arrangement recommended for the "E" class of locomotives is that shown in Figure 4, to be used with an exhaust nozzle of 5¾ in. diameter.

4. The outside and inside stacks as now used on this class of locomotive appear to give better results than can be obtained with the form recommended by the Master Mechanics' Committee, and it is thought advisable to retain them.

5. The best results were obtained when the passage for the gases under the diaphragm was smooth and free from abrupt changes of form.

6. The inclined adjustable diaphragm plate, often used, was found to cause an obstruction to the flow of gases and is undesirable. In the experiments made, the height of the whole horizontal plate of the diaphragm was varied and the final position recommended is suitable for any locomotive of this class and any means for adjustments is not considered necessary.

Washing Out With Hot Water.—The National hot-water locomotive boiler washing and filling system was installed and placed in operation at the Bellefontaine roundhouse in December, 1909. It is equipped with two Dean duplex pumps 12 x 8½ x 12 in.; the capacity of the filling pump is 500 gallons per minute; the washout pump will wash three boilers at a time with a pressure of 90 lbs. The filling storage tank has a capacity of 12,000 gallons, and the washout tank a capacity of 85,000 gallons.

It takes 1 hour 56 minutes to wash and fill a boiler, including the cooling of the boiler and letting out of the water. You can wash a boiler quicker than this, but I doubt if you can do it right. The water in the washout tank is ordinarily about 185 deg. Fahr., being regulated by a valve on the cold water line. This valve is actuated by a thermostat inserted in the tee in the suction line, the thermostat assuring a positive temperature of the washout water. The filling water is ordinarily about 190 to 200 degrees Fahr.

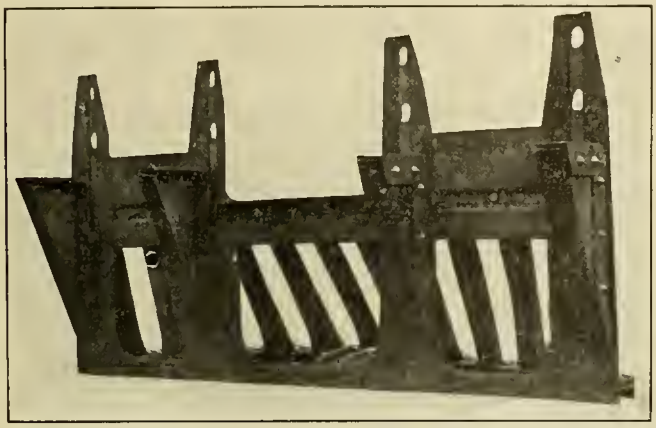
This plant saves water, saves fuel, removes the mud and scale in the boiler before it gets baked, and saves leaky flues.—*C. H. Voges at the General Foremen's Convention.*

Output of New Shops.—The output of the new shops of the Frisco at Springfield, Mo., for April was 42 locomotives and 46 passenger cars. Seven locomotives were given new fireboxes. The shop worked 25 days during the month with no overtime and had an average of 720 men in the locomotive department.

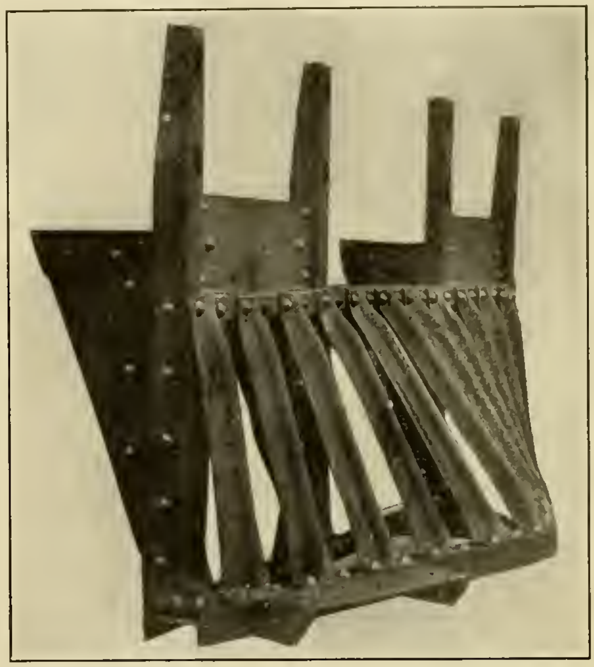
STEEL LOCOMOTIVE PILOT.

It is the experience of most roads in the maintenance of locomotive pilots that a large percentage of the breakages are due to the pilots striking something, especially coming in contact with each other at the coal docks and ash pits. This difficulty can be eliminated with the wooden pilot by shortening it up but it is rather a difficult matter to design a shorter wooden pilot of sufficient strength, and to eliminate the trouble steel pilots are usually employed, being in quite general use on many roads.

On the Lake Shore & Michigan Southern Railroad a new design of steel pilot has recently been put into service, which has many features of advantage over the usual arrangement of



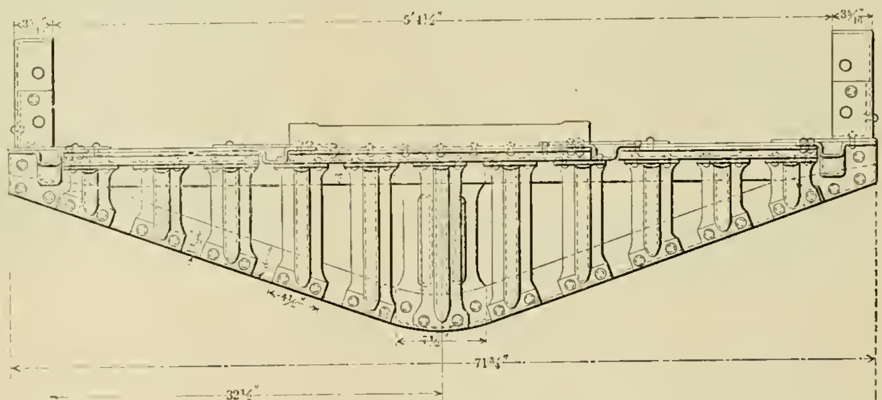
BACK OF STEEL PILOT.

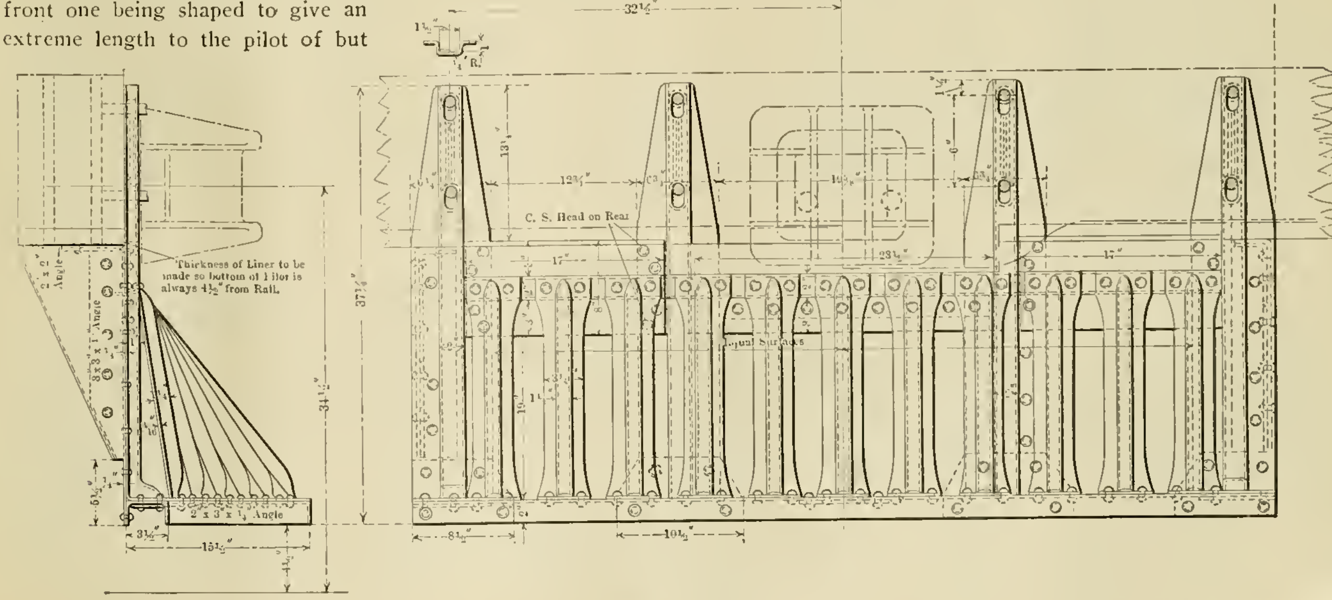


GENERAL VIEW OF STEEL LOCOMOTIVE PILOT.

steel bars and angles. This design is made up almost entirely of pressed steel parts which are formed to give a maximum strength and stiffness with minimum weight. One of these pilots for a freight engine weighs but 340 lbs. as compared with 830 for the wooden pilot which it displaced. It is also found that the steel pilot is much cheaper to construct.

Reference to the illustrations and photographs will show the construction. The work is largely done in the blacksmith shop, the different members being formed in the bulldozer and require but little fitting. The base is made up of 2 x 3 x ¼ in. angles with the vertical flange extending downward, the front one being shaped to give an extreme length to the pilot of but 15½ in. The horizontal flanges of the angles are sheared off at the ends so as to fit together and a ¼ in. plate is provided for making the connection. There are also two horizontal pressed steel stiffening pieces from the nose of the pilot to the back angle. To the base is secured four pressed steel verticals which are flanged with a foot on the bottom to be riveted to the angle, and are further stiffened by a vertical plate in the back. The top bar consists of a ¼ in. plate pressed in form to give stiff-





VERY LIGHT LOCOMOTIVE PILOT MADE OF PRESSED STEEL—LAKE SHORE AND MICHIGAN SOUTHERN R. R.

ness and secured between the flat surface of the uprights. The centre plate is not as high as the two side ones and is reinforced by an angle on the back. Between the top bar and the base are riveted the pressed steel bars, which are flanged over on the bottom to give a strong and stiff connection to the base. The form and appearance of these bars is well shown in the illustrations.

The four brackets under the bumper are made up of 3 x 3 x ¼ in. angles reinforced by a ¼ in. flanged gusset plate. These extend well down toward the base of the pilot and are about 9 in. in length at the top. The holes in the uprights where they are secured to the bumper beam are slotted and liners can be inserted or removed from below the beam so as to always maintain the pilot at the proper distance from the rail.

NEW LOCOMOTIVE REPAIR SHOPS.

WHEELING & LAKE ERIE RAILROAD.

There is just being completed, at Brewster, Ohio, a new shop for repairing locomotives, which presents several novelties in design that makes it a most interesting study. It was designed by V. Z. Caracristi, consulting engineer, and is being erected by Westinghouse, Church, Kerr & Co.

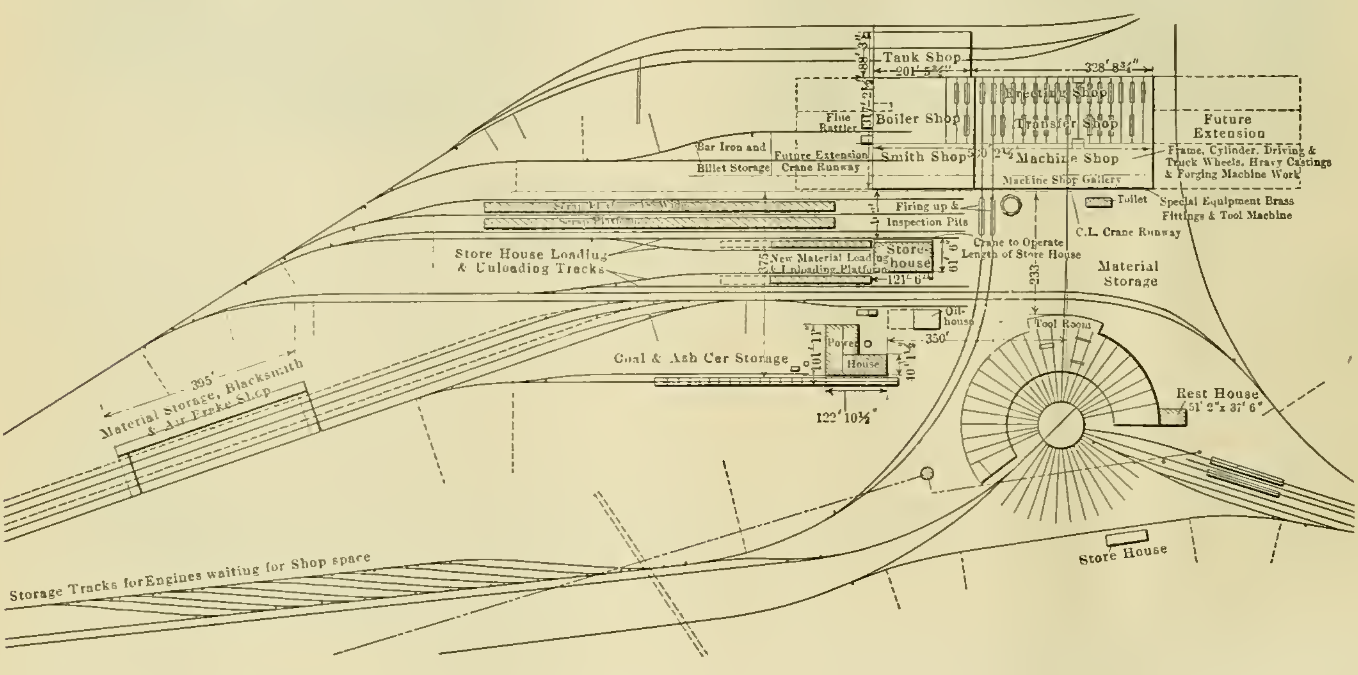
The shop plant proper consists of but three main buildings. One measuring 229 ft. by 530 ft. 2½ in. contains the erecting shop, machine shop, boiler shop and blacksmith shop. The tank shop, 88 ft. 3 in. by 201 ft. 5¾ in., is an extension on the side of the same building. The other two structures are a store house and a power house.

It is the large locomotive shop that presents the point of greatest interest, although the general arrangement of the whole plant is very carefully worked out. One of the illustrations shows a cross section of this building, in which it will be seen that it is divided into three principal bays. The erecting shop proper contains 16 pits in addition to two, in the same bay, which are in the boiler shop. Back of these is a bay served by a 150 ton crane, which is termed the transfer shop. The tracks from each of the erecting shop pits extend into this bay and several of them are provided with pits at this point. The next bay is the machine shop, served by a 10 ton crane over the heavy machines and having a gallery over the space for the lighter machines.

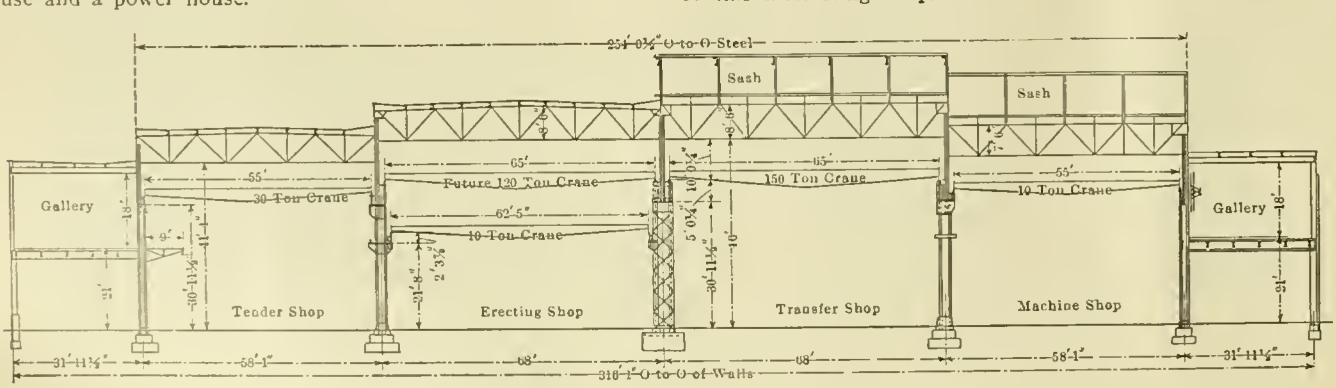
This arrangement is based on the idea of obtaining the advantages of a transverse erecting shop served by a transfer table and at the same time eliminating the serious disadvantages of the transfer table itself. This transfer shop, served by a 150-ton crane, has been installed to take the place of the table and locomotives coming into the shop are stripped in this space, removed from their wheels, set on lorry trucks and pulled into the erecting shop.

Here the erecting shop work is done up to the point of rewheeling, when they are pulled back into the transfer bay, rewheeled and finished. In this manner the space ordinarily taken up by a transfer table is utilized for the erecting work and for the storage of material taken from the locomotives. It permits the segregating of the stripping, wheeling, piping and painting work from the erecting shop proper and thus greatly increases the capacity of the plant.

In a later issue will be given a complete illustrated description of this interesting shop.



GENERAL ARRANGEMENT OF NEW LOCOMOTIVE REPAIR SHOP PLANT AT BREWSTER, OHIO—WHEELING AND LAKE ERIE R. R.



SECTION OF LOCOMOTIVE SHOP AT BREWSTER, OHIO.

FOR THE SHOP SUPERINTENDENT AND FOREMAN.

SOME INTERESTING DEVICES AT THE READVILLE SHOPS OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

MILLING CYLINDER BUSHING PORTS.

At the Readville shops a large vertical milling machine has been adapted for milling the ports in cylinder bushings. The arrangement consists of a plate mounted on the revolving table of the machine, which has a series of circular steps to fit inside of the different bushings. These are mounted vertically and

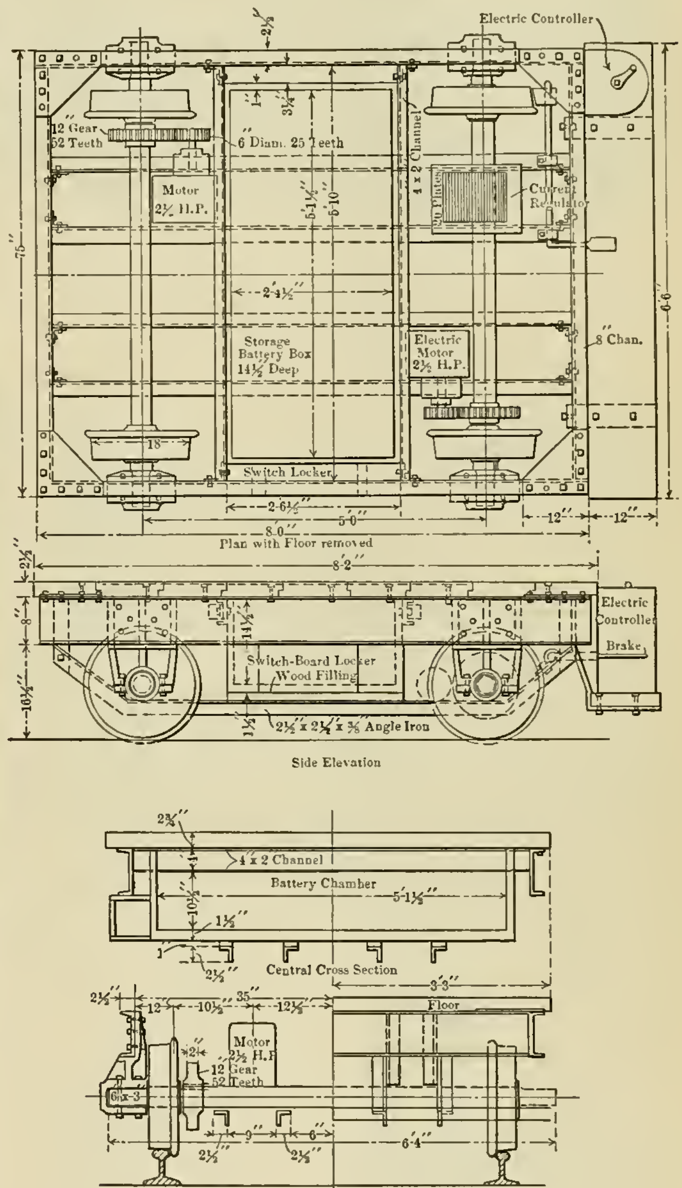
JIG FOR MILLING STEAM PORTS IN CYLINDER BUSHINGS. THE MILLING CUTTER HAS A VERTICAL ADJUSTMENT AND THE PLATE ON THE TABLE IS ARRANGED TO PERMIT THE QUICK AND EASY CLAMPING OF ALL SIZES OF BUSHINGS. THE CIRCULAR MOVEMENT OF THE TABLE IS AUTOMATIC AND THE PORTS ARE MILLED WITHOUT REQUIRING ANY DRILLING.

held by long bolts and straps across the top. A horizontal shaft carrying a milling cutter has been applied and is driven from the vertical shaft through a bevel gear. This cutter is also arranged to do the drilling, so that the whole operation of forming the ports in the bushings is done by one machine.

ELECTRIC MOTOR TRUCK.

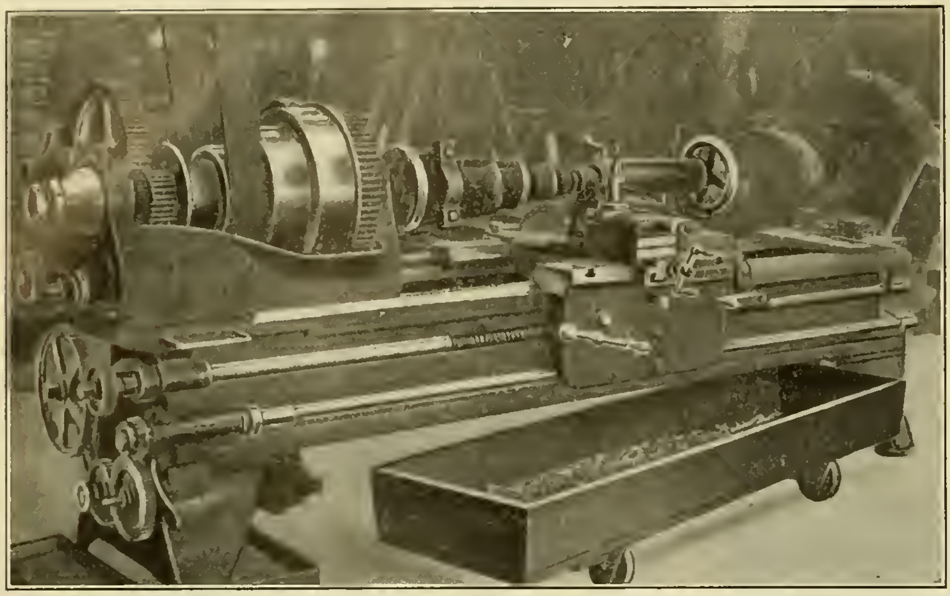
Normally railroad shop plants are not extensive enough to require a complete system of electric railway, such as are found in large industrial plants, but they are often so extensive that a large number of men are constantly employed pushing heavily laden trucks from one department to another.

At the Readville shops a storage battery electric truck has been built, which in addition to carrying its own load can also push several other loaded trucks. It is of a size suitable to fit the turntables and by its use the gangs of laborers are steadily employed in loading and unloading the trucks at the different points instead of pushing them around the plant.



DETAIL DRAWING OF ELECTRIC MOTOR TRUCK.

The design consists of a frame of steel channels and angles mounted on two pairs of 18 in. wheels, each axle being geared to a 2½ h.p. electric motor. A box 2 ft. 4½ in. wide and about 5 ft. long, supported in the center between the axles, is provided for the storage batteries. One end is fitted with a foot plate and an electric controller is located at one corner at this end. The controller permits operation in either direction and at several speeds. This truck is very powerful and has been found to be particularly convenient for lumber and heavy castings. A second one is now being built.



VIEW SHOWING THE CHIP BOX UNDERNEATH A CRANK PIN LATHE. THIS BOX IS MOUNTED ON ROLLERS SO THAT THE CLEANER CAN MOVE IT OUT OF THE WAY WITHOUT INTERFERING WITH THE WORKMAN.

CHIP BOX FOR LATHES.

The accompanying illustration shows a simple design of a box which is placed underneath a lathe for catching the chips. It is mounted on swivel rollers and can be drawn out of the way and cleaned without interfering with the man working at the machine. It can be made waterproof if necessary, and has proven to be a most satisfactory arrangement under several of the machines at the Readville shops.

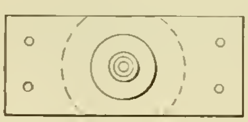
CONTINUOUS FEED VALVE FOR AIR CYLINDER.

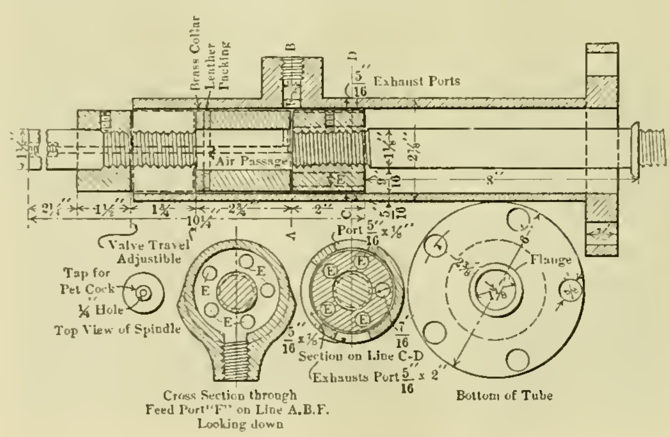
For use on a punching press operated by a 10 inch air brake cylinder a special design of feed valve has been designed, which gives a positive and continuous stroke of any length desired.

Reference to the illustrations will show that there is a piston rod extending up from the main piston through a small cylinder, which can be termed the valve cylinder. On this rod there are three plugs, the two outer ones being secured but adjustable as to length, and making a fit on the inside of the cylinder. The third is free to move on the rod and in the cylinder, but is fitted with leather packing to prevent leakage. It is mounted between the other two. The lower plug has five 7/16 in. holes through it, and there is also a ¼ in. hole from the top of the piston rod through its center connecting to an opening just above the lower plug. There are three large exhaust ports in the side of the cylinder, which at the bottom of the stroke are opened by the lower plug. Reference to the detailed illustration will show this construction.

In the air line leading to the valve cylinder there is a small square box in which there is a small slide valve connected to a foot treadle. This opens or closes the air supply as desired.

The air being admitted at the port located just above the lower plug in the valve cylinder, when it is in the released position, passing through the openings in the latter, forcing the piston down until the rod in its downward movement moves the upper plug into contact with the center one and forces it downward sufficiently to close the air admission port. The exhaust ports

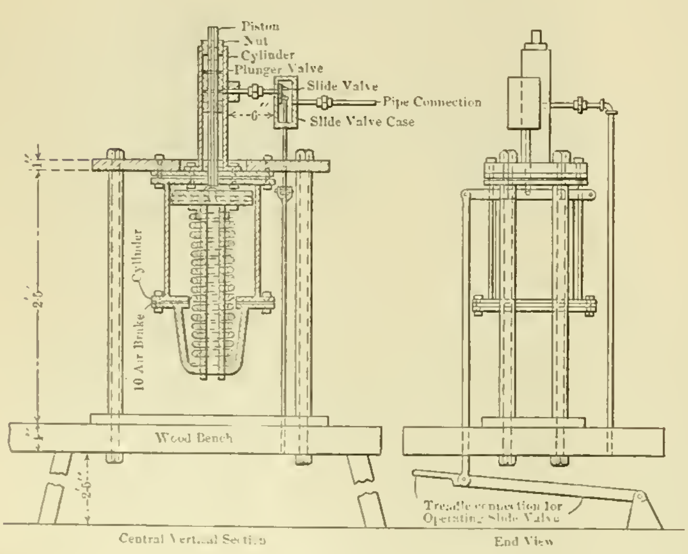




DETAIL OF AUTOMATIC AIR VALVE FOR PNEUMATIC PUNCH.

will then be open and the spring will return the piston to the top of its stroke. As soon as the piston reaches its top limit the air port is again opened by the action of the lower plug and the stroke repeated, so continuing as long as the pressure is maintained.

This feed valve is in use at the Readville shops and assures a positive stroke to the press or punch, regardless of the work to be performed.



GENERAL ARRANGEMENT AND APPLICATION OF AUTOMATIC VALVE TO PNEUMATIC PUNCH.

Gas vs. Gasolene for Heating Tires.—The following table gives the time and cost per average tire, or, better still, the actual cost per inch of diameter for heating locomotive tires, gasolene at $0.10 per gallon, commercial gas at $0.85 per 1,000 cubic feet.

Inside diam. of tire.	Gasolene.	Commercial gas.
42 in.	$0.1365	$0.1143
44 "	.1431	.1191
46 "	.1495	.1251
52 "	.1690	.1415
56 "	.1920	.1523
62 "	.2015	.1689
68 "	.2210	.1850
74 "	.2405	.2013
Average time per tire	17.52 min.	15.5 min.
Average cost per tire	$0.175	$0.1433
Average cost per diameter, inch..	.00325	.00272

—*H. D. Kelley at the General Foremen's Convention.*

TESTS OF JACOBS SUPERHEATER ON A TANDEM COMPOUND SANTA FE TYPE LOCOMOTIVE

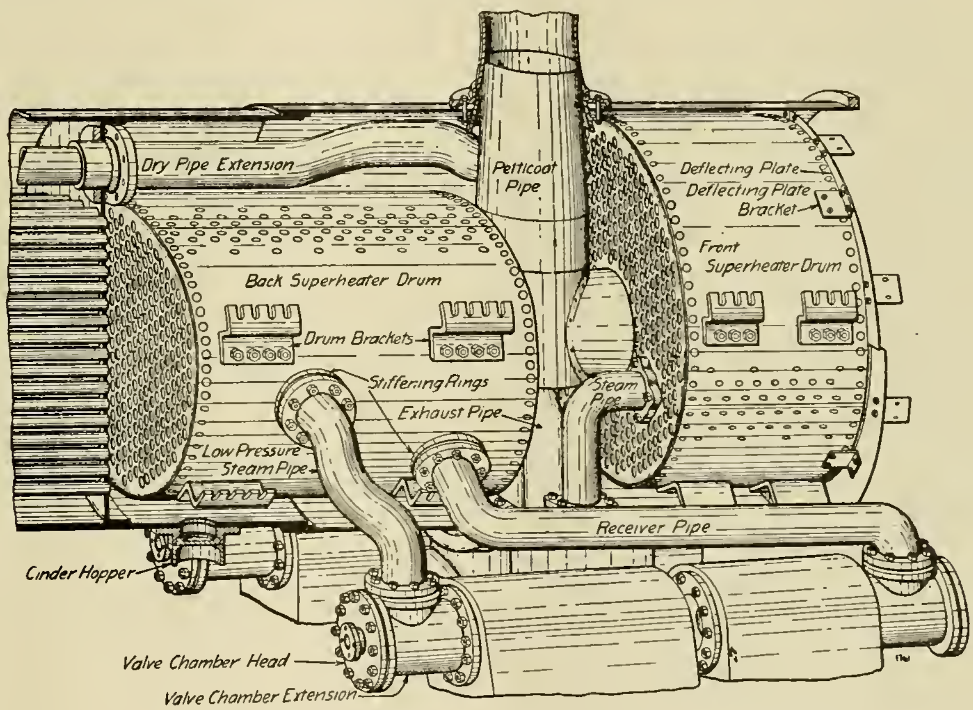
COMPLETE LOCOMOTIVE TESTS OF A TANDEM COMPOUND 2-10-2 TYPE OF LOCOMOTIVE FITTED WITH A JACOBS SUPERHEATER AND REHEATER AND AN IDENTICAL LOCOMOTIVE USING SATURATED STEAM. THE TESTS WERE MADE OVER A SECTION WHERE THE FULL CAPACITY OF BOTH LOCOMOTIVES WAS DEVELOPED.

Experience with the Baldwin smoke box superheater, as installed on quite a large number of freight locomotives on the Atchison, Topeka & Santa Fe Railroad, soon indicated that there was an opportunity of obtaining greater economy by the application of a superheater, which would give somewhat higher temperatures, coming within the limits of what would be called a moderate degree superheat. It was also indicated that, all things being considered, a superheater which does not require any deformation of the boiler was to be preferred.

To answer this purpose H. W. Jacobs, assistant superintendent of motive power, designed a fire tube drum type superheater which was applied to a locomotive in November, 1908. After a little over a year's performance the results indicated the superior qualities of this superheater over the low degree superheater as applied to other engines of the same class, and since that time the Jacobs superheater has been applied very generally to locomotives on the Santa Fe.

Since a large portion of the locomotives on this road are of the compound type, the superheater has been arranged in two parts, one drum being ahead of the exhaust pipe for superheating the steam on its way from the boiler to the high pressure cylinders and the other larger drum, located between the exhaust pipe and the front flue sheet acting as a reheater (see AMERICAN ENGINEER, December, 1909, page 481).

In June, 1909, engine 901, a tandem compound locomotive of the 2-10-2 type used on heavy mountain grades, was turned out of the Topeka shops equipped with a superheater of this type. One of the illustrations gives a perspective view showing the arrangement and connection of the superheater as applied to this locomotive. It consists simply of two steel drums, fitted with a series of horizontal fire tubes between the heads, located in the front end and the necessary steam pipe connections. In the earlier stages of the development of the superheater considerable experimental work was done to determine the proper diameter of fire tubes for the most satisfactory results. These researches indicated very strongly the superiority of the 2¼ in. tubes, which have since been used. The shells of the two drums are ⅝ in. boiler plate and the heads are flanged in the same manner as front flue sheets on locomotives. The rear drum is made oval in cross section to provide room for the passage of the dry pipe extension to the front drum, which is circular in cross section. The rear drum is placed about 24 in. ahead of the flue sheet and a manhole (not shown) provided in the bottom of the smoke box gives access to this space. There is a 6 in. central flue in the rear drum (not shown) in line with the 20 in. return flue in the front drum, permitting defective boiler tubes to be removed without taking out the superheater.



JACOBS SUPERHEATER AS APPLIED TO TANDEM COMPOUND LOCOMOTIVE NO. 901.

The rear drum, because of its situation directly in front of the flue sheet, is exposed to very high temperatures, subjecting the tube connection to severe expansion stresses. In order to prevent any possibility of trouble with leakage, the tubes in this drum are inserted without copper ferrules, rolled and expanded and are then welded at both ends by either autogenous or electric methods. It has not been found necessary to weld the tubes in the front drum, which are rolled, expanded and beaded in the same manner as boiler tubes.

The two drums are as light as consistent with safety and are of very compact construction, giving a maximum volume and superheating surface per unit of weight. They are held in place by Z shaped brackets which are slotted and located so as to permit free expansion in all directions.

In the interior of both drums baffle plates of thin steel are inserted, being located to direct circulation equally over all of the tubes. These baffle plates direct the steam in such a manner as to give a scrubbing action over the surface of the tubes to remove the non-conducting film of highly superheated steam and thus permitting the greatest possible transmission of heat from the tubes to the steam. Deflector plates are placed around the back end of the rear drum to close the space between it and the front end shell and also around the forward head of the front drum, a space 18 in. wide at the bottom, however, being left open to prevent the accumulation of any cinders in the bottom of the smoke box. It will be seen that the gases from the boiler tubes must pass through both drums, are then reversed and turned through the large central flue in the front drum to an enclosed petticoat pipe which connects directly to the stack.

From the very start locomotive No. 901 with the superheater showed itself superior to other locomotives of the same class. It started quicker, hauled a greater tonnage, and used less fuel. While it has been generally conceded that superheated steam is of considerable value in passenger service, its economy in freight service at low speeds has not been definitely settled, and in order to determine its value under these conditions, arrangements were made for a thorough test of engine 901, operating under ordinary conditions of road service, and to make a similar test of another engine of the same class (No. 923) not equipped with a superheater, and thus get the comparative results to determine the value of superheated steam for compound freight engines.

The engines both belong to what is known as 900 class, which were designed and built by the Baldwin Locomotive Works, being of the 2-10-2 tandem compound type. They were first introduced on this road about eight years ago, and until the advent of the Mallet Articulated compound locomotives in this country, were the largest locomotives in the world. They were very fully illustrated and described in the following issues of this journal: October, 1903, page 372; November, 1903, page 398, and May, 1904, page 176. The general appearance is shown in the illustration indicating the location of the instruments and the general dimensions of both the locomotives under test are given in the table in the next column.

These locomotives are used in miscellaneous pushing and heavy freight service on the heavy grades of the Southwest, where the Santa Fe Railroad crosses five ranges of mountains, on which the maximum grades vary from 2 to 3½ per cent. Due to the heavy weight of the reciprocating parts they have a limited speed of 25 miles per hour. Greater speeds can be obtained, but at an increased expense for maintenance. Of these engines seventy are fitted as coal burners and 90 as oil burners. In starting heavy trains on 3 and 3½ per cent. grades they will exert a draw bar pull of 75,000 pounds, and can maintain a 45,000 pound draw bar pull at ten miles per hour on a 3 per cent. grade. The actual rating on through freight trains is given in the following table:

Grade, feet per mile	Grade, per cent	Tonnage rating
184.8	3.5	640
158.4	3.0	600
132.0	2.6	650
105.6	2.0	950
79.2	1.5	1150
52.8	1.0	1350
26.4	0.5	3300

No changes were made in the construction of engine 901 at the time of the application of the superheater except those necessary in the design of steam pipes and the moving of the front flue sheet back 42 in. While the shortening of the flues reduced the flue heating surface considerably, it did not prove to seriously affect the steaming qualities of the boiler. No changes were made in the valve setting, which is given in the table below.

It was necessary, of course, to entirely change the front end drafting arrangement of the locomotive with the superheater, as it does not require the use of any netting or baffle plate. Cinders and sparks striking against the two drums are whirled around the front of the front drum and by the time they leave the stack are extinguished. There are not as many sparks drawn into the front end as the draft is more constant and steady. Engine 901 was provided with a 5⅝ in. nozzle, while 923 required a 5¾ in. nozzle. This fact, however, is not apparent from the indicator cards, which showed that the size of the nozzle can be varied ¼ in. in diameter without materially affecting the back pressure.

Both locomotives were fitted with brick arches and tests were also made without arches, which, although they were not extensive enough to be conclusive, clearly indicated the great value of the arch as a fuel saver.

The general dimensions and valve setting of both these locomotives is given in the following table:

Engine Number	901	923
Weight in working order:		
Tender, pounds	165,800	165,800
Drivers, pounds	234,580	234,580
Truck, pounds	52,660	52,660
Total, engine, pounds	287,240	287,240
Total, locomotive, pounds	453,040	453,040
Wheel base:		
Rigid	19 ft. 9 in.	19 ft. 9 in.
Engine	35 ft. 11 in.	35 ft. 11 in.
Total	66 ft. 0 in.	66 ft. 0 in.
Tank capacities:		
Water, gallons	8,500	8,600
Coal, pounds	27,000	27,000
Boiler:		
Type—wagon top, radial stay, wide firebox.		
Outside diameter, first ring, inches	81.05	81.05
Capacity, with water surface at level of second gauge cock:		
Water space, cubic feet	483.0	562.8
Steam space, cubic feet	84.2	94.6
Flues:		
Number	391	391
Outside diameter, inches	2.25	2.25
Thickness, inches	0.125	0.125
Length between sheets, inches	197	239
Total fire area, square feet	3,360	4,077
Arch—fire area, square feet	12.8	12.8
Firebox:		
Length inside, inches	104.25	104.25
Width inside, inches	78	78
Depth front end, inches	74.5	74.5
Depth, back end, inches	72.5	72.5
Fire area, square feet	209	209
Total heating surface, based on inside of firebox and inside of flues, square feet	3,582	4,299
Grates, rocking finger—area, square feet	58.5	58.5
Ratio heating surface to grate area	61.24	73.84
Ratio fire area through flues to grate area	0.147	0.147
Ratio firebox heating surface to grate area	3.57	3.57
Ratio flue surface to firebox heating surface	16.08	19.61
Drivers:		
Diameter, inches	57	55.375
Cylinders:		
High pressure, right, diameter, inches	19.125	19
High pressure, left, diameter, inches	19	19
Low pressure, right, diameter, inches	32	32
Low pressure, left, diameter, inches	32	32.5
Stroke of piston, all cylinders, inches	32	32
Valves:		
Type—piston valve.		
Type of link motion—Stephenson, open rods.		
Greatest valve travel, inches	5.25	6.25
Receiver volume:		
High pressure superheater, cubic feet	33.7	
Low pressure superheater or receiver, cu. ft.	34.5	6.0
Dimensions of valve setting:		
Steam ports, high pressure	1⅝ in.	1⅝ in.
Exhaust ports	6 in.	6½ in.
Bridge	3¾ in.	3¾ in.
Eccentric throw	6 in.	6 in.
Outside lap, high pressure	⅞ in.	⅞ in.
Outside lap, low pressure	¾ in.	¾ in.
Inside lap, high pressure, negative	¼ in.	¼ in.
Inside lap, low pressure, negative	⅜ in.	⅜ in.
Valve travel, front	5⅝ in.	5½ in.
Valve travel, back	5 in.	5⅜ in.
Saddle pin, set back	¾ in.	¾ in.
Lead full gear	line and line	line and line

The tests were made on the first district of the Mexican Division of the Santa Fe between La Junta and Trinidad, Colo., a distance of 81.5 miles, of which 50 miles is an almost constant grade of 59.7 ft. per mile, the remainder having the same ruling grade, but all rolling.

Careful arrangements were made to obtain full data as to actual performance of engine relative to coal and water consumption, quality of steam, boiler pressure, height of water in gauge glass, throttle and reverse lever positions, the drafts in the firebox and front end, degrees of superheat to cylinders, indicated horsepower, dynamometer horsepower, draw bar pull, speed and tonnage hauled. The diagrammatic arrangement of the apparatus as installed on the superheater locomotive is shown in one of the illustrations. The tests were made in actual mountain service with heavy tonnage trains. The engineer was instructed to make no difference in the general operation of the engine on account of tests and the regular engine crews, who had for a considerable time been assigned to the different engines were used, so that the results of tests might be more nearly in conformity to actual operations. The conditions of road service do not permit of a constant position of either reverse lever or throttle over the road, but require continual changing in position in order to maintain regular speed and prevent excessive draw bar pulls with long trains and consequent break-in-twos. As a consequence the records show considerable irregularity in performance on account of curves and grades. The average results, however, show considerable regularity in that there is such a correspondence in results recorded and grade conditions as to identify the operation of the engine on any particular portion of the trip. The special importance, then, to be laid on the records is that they contain in detail the history of all changes made and that readings were taken frequently enough to obtain this data.

TESTING APPARATUS.

Coal Measurements.—All the coal used for the various trips came from Willow mine number five, located at Hebron, New Mexico. One car load of coal was sacked at a time, each sack containing 200 pounds. Enough coal for each run was taken from the car of sacked coal and placed on the tender at terminals. Before beginning a test run, the condition of the fire was noted and care was taken that it was clean and even; at the end of the run the same condition was approached as nearly as possible.

The sacks were emptied to the fireman as needed, so that no more than 500 pounds of coal was open at any one time. The time of emptying each sack was noted, a careful record was kept of the number of shovels of coal used by the fireman as well as the time of firing. An exact record was kept of the number of shovels of coal fired.

Samples of coal from different sacks were taken during each test run, and from the accumulation of samples of fifty pounds a sample for each test was obtained by the standard method of quartering. The average samples thus obtained were analyzed and efficiencies for the runs were based upon the results of this analysis.

Water Measurements.—Three-inch Empire hot water meters were placed in each branch pipe; by-pass pipes for use when the engine was not under test were arranged to protect the meters. The meters were constantly chcked by comparison with readings of gauge glasses on right front and left back corner of engine tank. Before the series of tests the engine tender was leveled and calibrated by weighing in water fifty gallons at a time. By leveling the tank and filling it with water and noting simultaneous readings of meter and tank gauges, the meters were calibrated and correction factors determined. The overflow of water from the injectors was discharged into calibrated cans, each of nine gallons capacity. As soon as the cans were nearly filled the amount was noted and cans were then emptied. A one and one-half inch Empire hot water meter was placed in the discharge from one of the overflow cans in order to check the method of measuring the overflow. The total amount of water overflowing from the injectors varied considerably on different runs and on different engines, depending very much upon the condition of the injectors. The amount of overflow was deducted from that shown by the injector meters, in determining the amount carried to boilers. No credit, however, was allowed for tbe heat in the water lost.

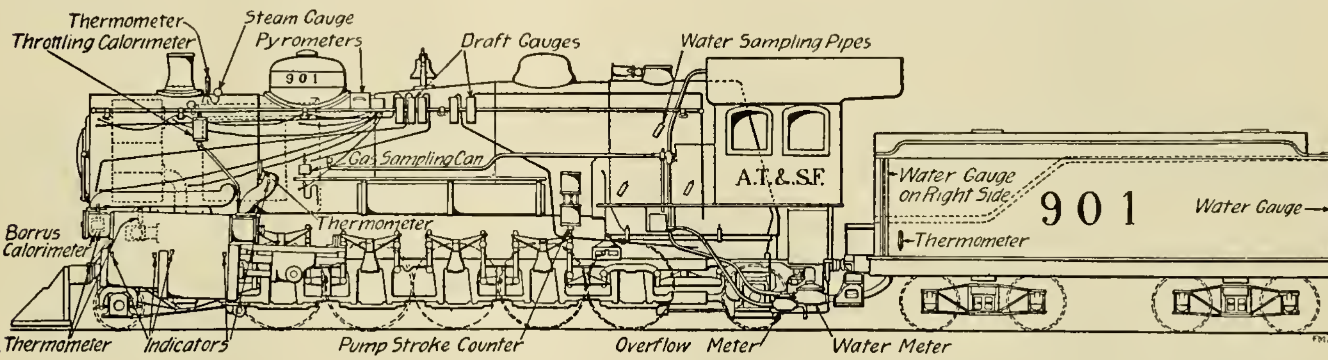
Quality of Steam.—Tbe quality of the steam was determined at the dome for engine 923 and in the dry pipe extension for engine 901. The calorimeter was of the Peabody throttling type and of latest design for this work. The calorimeter itself was carefully lagged. The calorimeter for finding the quality of steam leaving the high pressure cylinders was of the separating type, a Barrus universal steam calorimeter of the 1895 type.

Pressure Measurements.—Crosby steam gauges were used in the cab and on the calorimeter. These gauges were tested constantly by means of the Crosby dead weight steam gauge tester. Pressures in the superheater and receiver of the engines were obtained by special piping to the steam indicators. A Short & Mason compensated barometer was used for taking atmospheric pressures. These pressures varied constantly during the trip on account of changes in elevation.

Draft Measurements.—"U" tubed draft gauges containing water were used in obtaining the drafts in the smoke box, between superheaters, in the firebox and in the ashpan. These gauges were bolted on the hand rail, and pipe connections were made to the gauge board from the various points where drafts were desired.

Temperature Measurements.—Thermal couples were used for measuring the smoke box temperatures. The Hoskins pyrometer was used for this purpose. The apparatus consisted of an eight-point switch with proper connections to front end. All the readings were taken from one instrument fastened on the hand rail. The couples themselves were of one-sixteenth inch material, and were very sensitive to changes in temperature, so that differences in temperature in gases at top or bottom of smokehox were shown almost immediately. The pyrometer itself was so substantial in construction that after several months of service it showed upon test to be registering accurately.

An angle thermometer reading up to 212 degrees was used in obtaining temperatures of feed water. This thermometer was placed in the front of the engine tender close to suction pipe. Thermometers reading up to 600 degrees Fahrenheit were used in determining the superheat of steam to cylinders. These thermometers were tested from time to time against standard thermometers and proper corrections made.



LOCOMOTIVE NO. 901 AS EQUIPPED FOR ROAD TESTS.

POWER MEASUREMENTS.

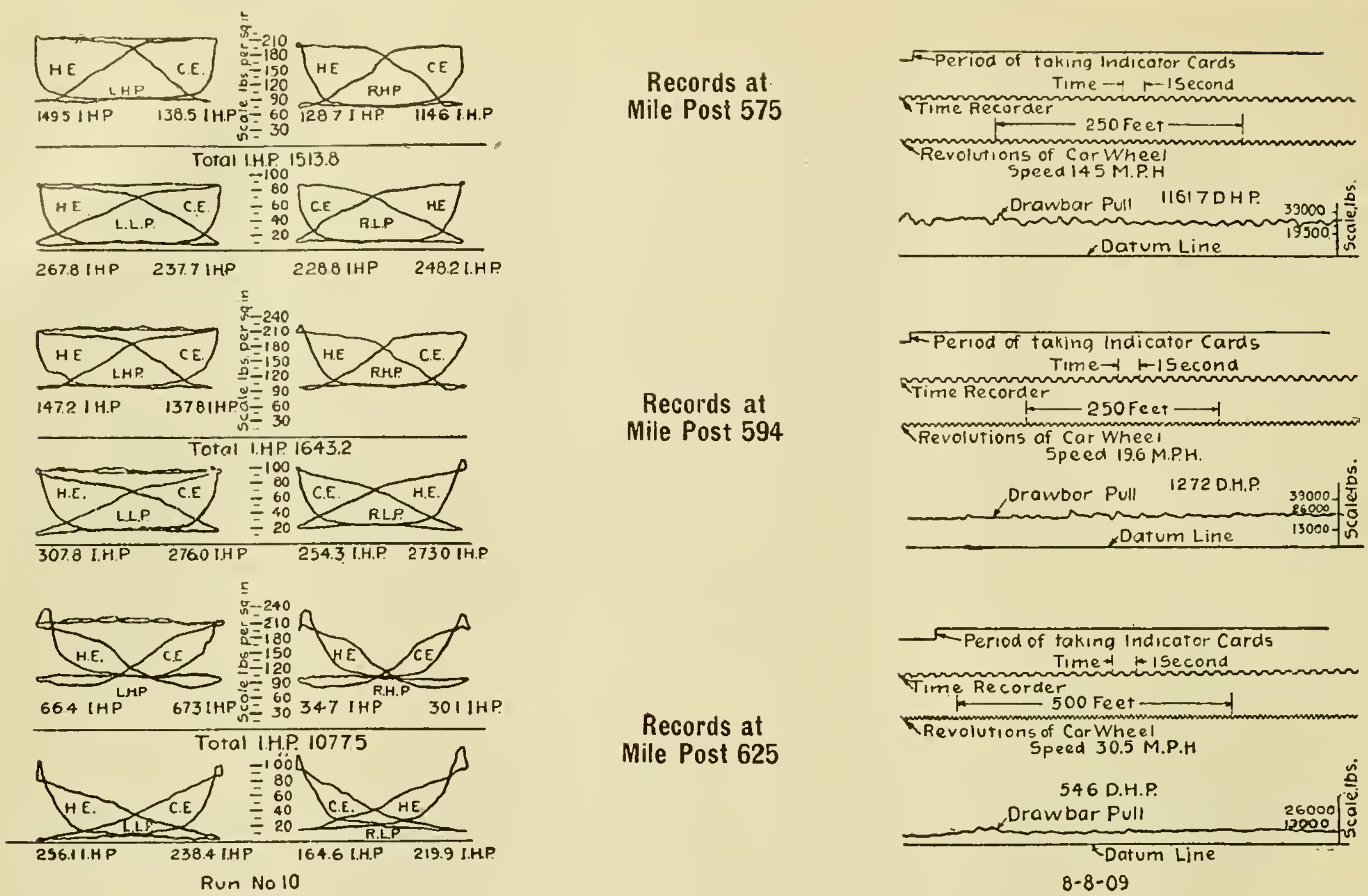
Indicated Horse Power.—The latest type of Crosby continuous outside spring indicators were used. The springs were tested before each series of runs. The indicators themselves were carefully tested for parallelism at various times throughout the tests, and were constantly tested for free, easy pencil movement, since in a series of road tests there is more or less dust or sand to interfere with operation of indicators.

While thirty-six cards may readily be taken at one time with the continuous indicator, yet it was found, after numerous trials, that three showed very accurately the information desired. Three were taken at each reading, and in working up the data the middle card was used as a sample; the other two cards indicating that the conditions just before and after taking the card differed not greatly from that at the time of taking the card. Cards were taken from all four cylinders simultaneously and connections were made to the dynamometer car so that an offset was made on the chart registering the beginning and end of each period of taking cards. This method of registering indicated accurately the location on road where cards were taken.

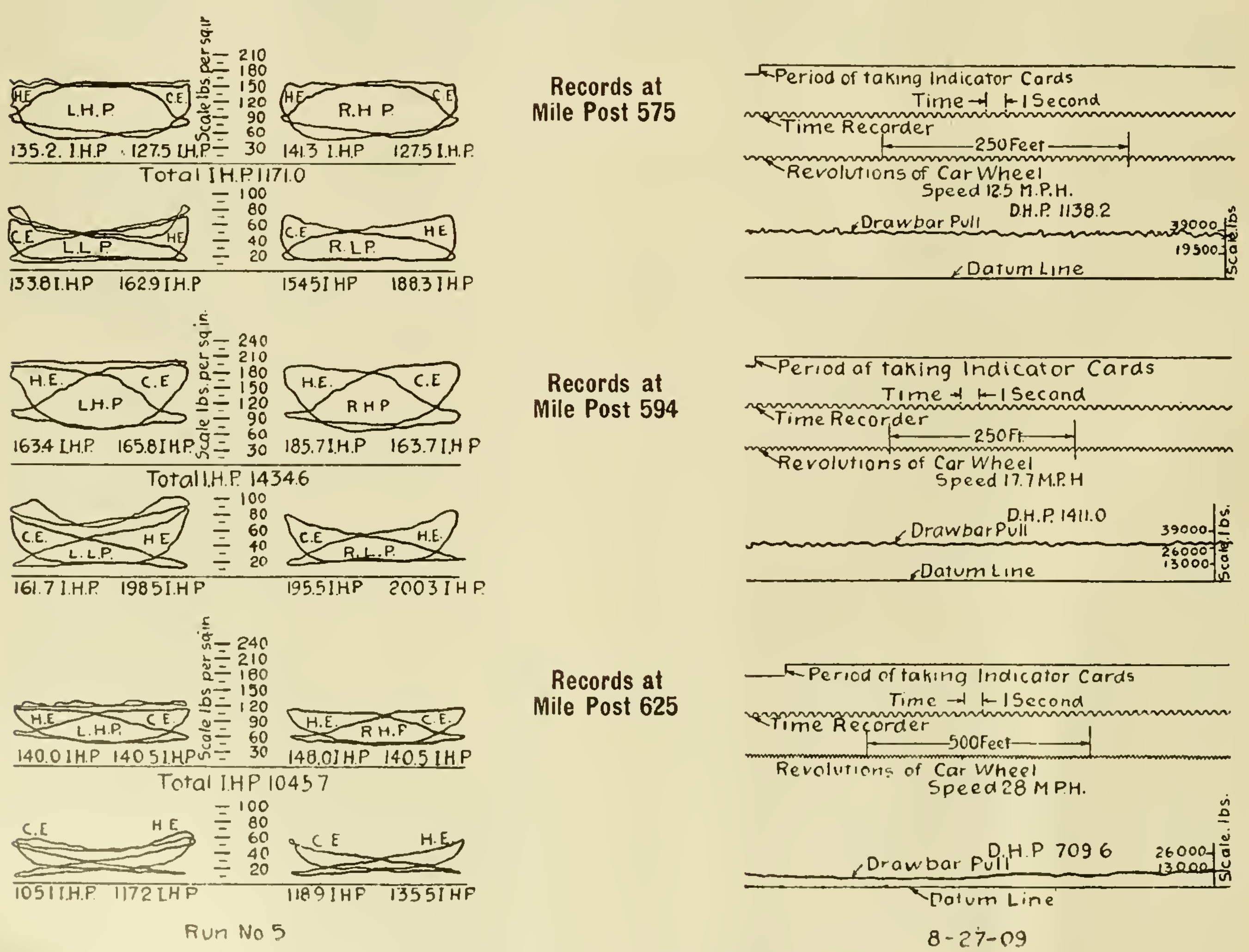
The indicator reducing motion was of the slotted lever type, which took its motion from the engine cross-head and in turn drove a small cross-head. The second cross-head had a light tube or motion rod. On this tube were adjustable fingers to which the indicator drum cords were attached.

Dynamometer Horse Power.—To determine accurately the work done by the engine and the resistance of the different trains, a dynamometer car was used. This car is known as the Westinghouse Air Brake Car number five, and was obtained from the Westinghouse Company for making this series of tests. The dynamometer itself is of the diaphragm type and is capable of recording very high drawbar pulls and buffs.

The record of performance as shown on the twelve-inch roll attached to the chronograph shows very distinctly the variations in drawbar pulls at quarter second intervals. Time measurements of one-half seconds were shown by offsets in line on left side of the paper. Distance measurements in revolutions of the wheels were shown on the right side of the paper by offsets in pen line. The diameter of the wheel is such that the number of revolutions of the axle in six seconds gives the speed in miles per hour. The paper also records a base line upon which distance signals were recorded by an offset in the line, made by breaking the circuit on the part of tbe observer. Mile posts, time and stations were written on the chart.



SAMPLE INDICATOR CARDS FROM SUPERHEATER LOCOMOTIVE NO. 901.



SAMPLE INDICATOR CARDS FROM LOCOMOTIVE NO. 923.

A separate base line is used for recording of time during which indicator cards were taken. All data regarding dynamometer horse power, drawbar pull and speeds were obtained from the charts in the dynamometer car.

TONNAGE MEASUREMENTS.

The tonnage haul was taken from the conductor's wheel report. These reports show weight in cars as per waybills, and also light weight of cars. The light weights of cars were invariably checked by noting the actual light weight stenciled on cars in train and comparing them with the wheel report. In all cases the tonnage refers to the number of tons in the train and does not include tonnage of tender and engine.

OBSERVATIONS.

The determining of points at which readings should be taken is of great importance in road tests where results serve to indicate average performance. Even on up grades, such as in a territory between La Junta and Simpson, there are a great many momentum grades. On this account it is a difficult problem to choose points at which observations should be taken that will indicate, with any degree of fairness, the real performance of the engine.

In order to assure uniformity of readings, certain mile posts were chosen and the different observations were made at these mile posts. By such an arrangement the readings made served for an average performance obtained during the trip. The indicator cards were taken on an average of thirty times per run. The pyrometer, calorimeter, drafts, temperatures, height of water and boiler pressures were taken on an average of forty times per trip, throttle and reverse lever positions were noted for each change. Water meters were read at every mile post where indicator cards and calorimeter readings were taken, and also at the top and bottom of grades as well as at the time of stopping and starting of engine. The dynamometer readings were taken continuously from the start to the end of each trip, excepting on the trips from Trinidad to La Junta. On these runs the dynamometer records were cut out at Thatcher. The number of shovels of coal was recorded as fired; the number of sacks of coal, as emptied.

INDICATOR CARDS.

The application of a superheater between the high and low pressure cylinders of a tandem compound locomotive affords an opportunity for studying the effects of a large receiver volume on the distribution of indicated horse power between the high and low pressure cylinders for various engine speeds.

On the non-superheater locomotive, the receiver volume between the high and low pressure cylinders is very small, only amounting to six cubic feet, and furthermore the cylinder receivers on each side of the locomotive are entirely separate. The high pressure exhaust line follows closely the low pressure admission line and with equal ratios of cut-off, the ratio of indicated horse power in the two cylinders is nearly unity, averaging 1 to 1:21 for the entire runs. Any increase in speed tends to bring the ratio closer to unity so that both high and low pressure cylinders develop nearly the same amount of power.

Due to small receiver volume, the receiver pressure fluctuates greatly and records with distinctness the characteristic events of the stroke. On the superheater locomotive the receiver between the high and low pressure cylinders has a capacity of 34.5 cubic feet. Both high and low pressure cylinders exhaust into the one receiver at different quarters of the stroke, and thereby maintain a comparatively high receiver pressure. With the aid of the starting valve the pressure is raised to a maximum in one stroke. As soon as this pressure is attained, the back pressure line of the high pressure cylinders becomes a straight line parallel to the atmospheric line. While its height depends entirely on how hard the engine is working, yet it is never slanted downward nor does it follow the low pressure admission line as in the other locomotive.

Both high pressure cylinders exhaust at different times into a common receiver. Due to the large volume of this receiver, the admission line on the low pressure is maintained more nearly horizontal than on the engine without large receiver volume. The receiver is a superheater and also serves to re-evaporate water condensed in the high pressure cylinders, thereby greatly increasing the volume of the exhaust steam from the cylinders as well as making a further increase in volume by superheating. Accordingly there is always a tendency for an increase in the back pressure in the high pressure cylinders. These conditions cause an increase of pressure in the high pressure cylinder, reduce the mean effective pressure in the high and increase it in the low pressure cylinders, thereby increasing the horse power ratio between the two cylinders from 1 to 1.98 for the average of the entire runs. The lower the speed the more even the division of power. The higher the speed the greater the ratio in favor of the low pressure cylinder.

This distribution of power made engine 901 slightly more powerful at slow and average speeds than engine 923. At high speeds, however, the difference in power was less perceptible. The gain in horse power in the low pressure cylinder more than offset the loss in the high pressure cylinder, both at high and low speeds. The influence of a large receiver on starting is a most important one. If the starting valve is not sufficiently large or there is not a by-pass allowing steam at boiler pressure to enter the receiver through a quick opening valve the engine will be so slow in starting that the insufficient engine momentum acquired will be inadequate to start a heavy train. On this engine the simpling or starting valve was large enough so that the large volume receiver was quickly filled with steam at a good pressure. The first low pressure cards taken at starting showed from one-fifth to one-fourth more horse power than cards immediately following. This condition for starting made the engine exceptionally powerful, so that when necessary to stop for switching or for section men on steep grades or on bad curves, there was no great difficulty in starting the train. Other engines of her class under such conditions of stopping usually have to back up and run for the grades.

The indicator cards for engine 923 are typical cards for engines of this design, though the lead on cards at slow speed does not seem in all cases to be sufficient. The indicator cards of engine 901 are such as should be expected at slow speeds. At high speeds, however, there was considerable negative work in the high pressure cylinders, part of which was due to lack of lead and excessive compression and part to the way in which both high pressure cylinders exhausted at different times into the one receiver.

TEST RUNS.

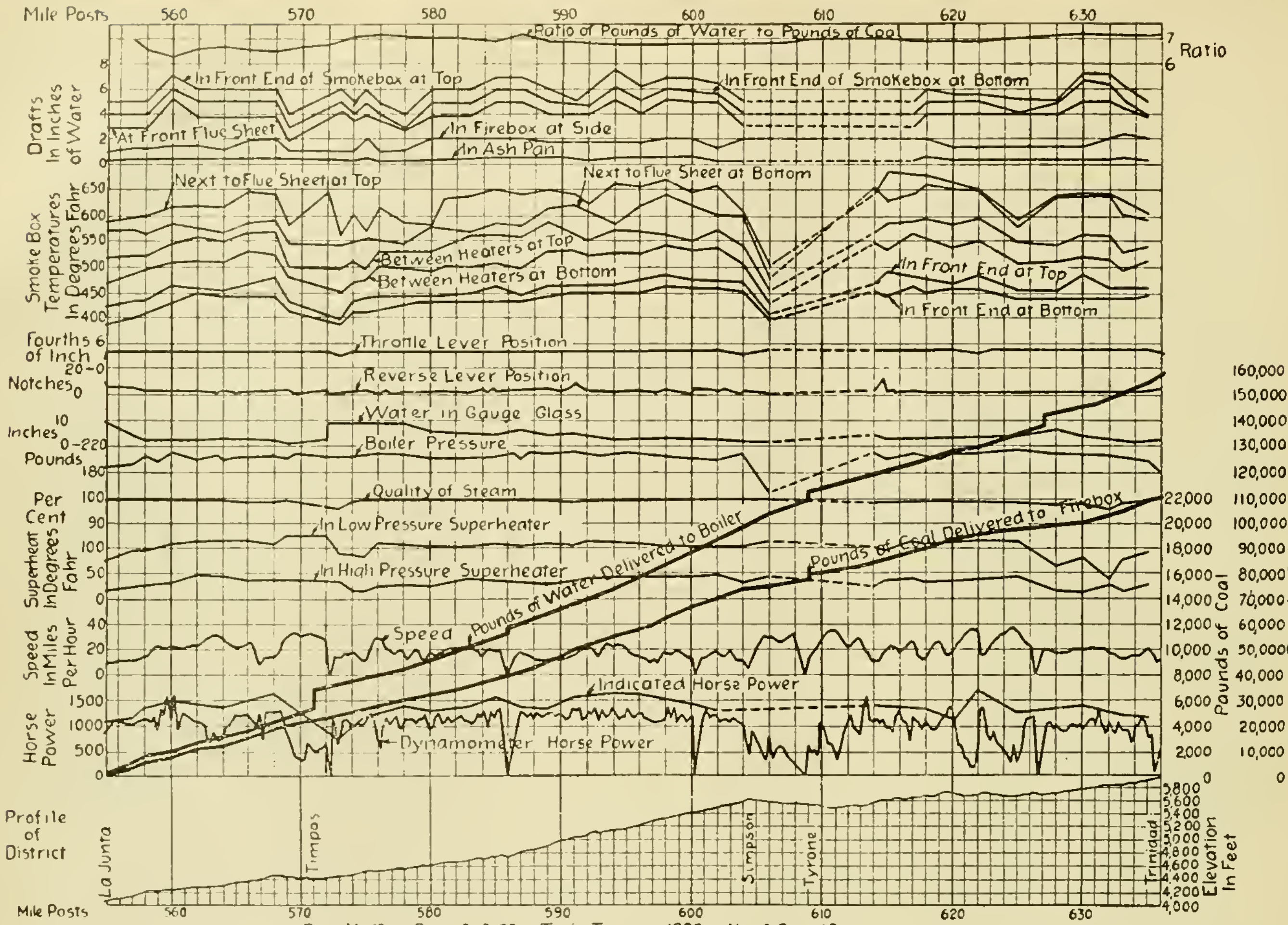
Preliminary Runs.—Several preliminary runs were made to determine the best drafting conditions and make such adjustments in test apparatus as to record specific data needed. The test runs were then made under the normal conditions prevailing and with such tonnage as available and under such condition of service, either through or local freight, as consistent with operative conditions.

Run No. 7, Engine 901.—This run was made from Trinidad to La Junta on August 4th. There were 2,875 tons in the train, consisting of sixty-five cars. The total time on the road was five hours and forty-two minutes. The total delayed time was one hour and thirty-eight minutes, leaving an actual running time of four hours and four minutes. Ten thousand one hundred pounds of coal were used during this trip, with an average coal consumption of 43.1 pounds of coal per thousand gross ton miles. The ashes removed at the end of the run amounted to 1,364 pounds; the ashes in the coal as fired as shown by analysis amounted to 1,044 pounds; 74,177 pounds of water were supplied to the boiler. The equivalent evaporation was 8.82 pounds of water per pound of coal, but by crediting the heat imparted by the waste gases to the superheaters, this was increased to 9.5 pounds of water per pound of coal. The theoretical evaporation for the coal used on the trip was 13.77 pounds of water per pound of coal, so that the boiler efficiency was 69 per cent. for the run.

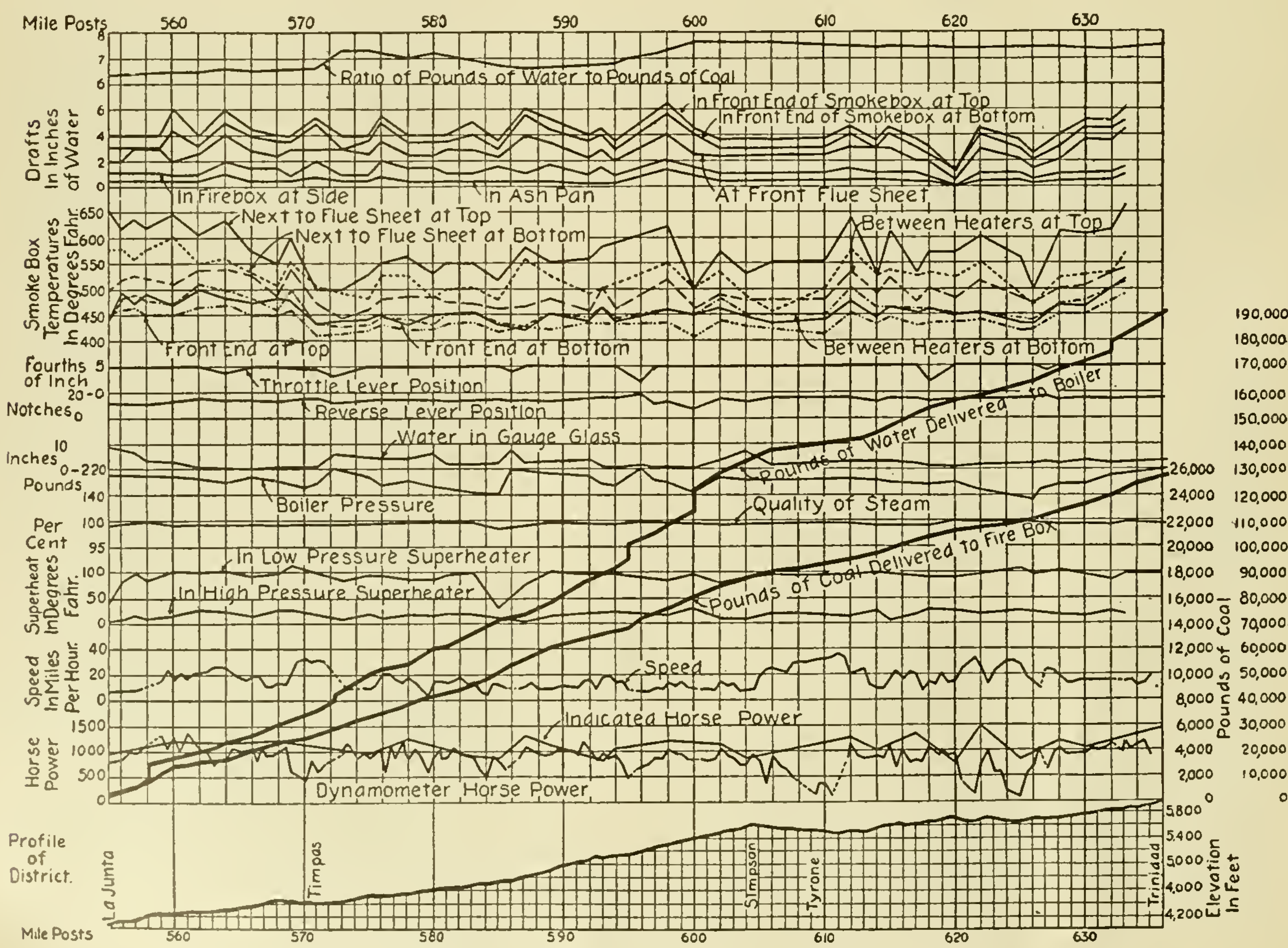
The maximum temperature of steam to high pressure cylinder was 418 degrees, that to low pressure cylinder was 448 degrees. The maximum superheat in high pressure cylinders was 39 degrees, in low pressure cylinders 105 degrees.

Run No. 9, Engine 901.—The run was made from Trinidad to La Junta on August 7th. There were 3,009 tons in the train of eighty-one cars. The total time on the road was seven hours and twenty-eight minutes; the total delayed time was three hours, so that the actual running time was four hours and twenty-eight minutes. The causes for such unusual delays as occurred on this trip were due mostly to a broken knuckle and hot boxes on cars in train. During periods of delay 1,200 pounds of coal were consumed. The total coal consumed for the run amounted to 9,300 pounds, or 37.9 pounds per thousand gross ton miles. The total ash removed was 1,346 pounds, while that in the coal as fired, as shown by analysis, was 1,201 pounds. Sixty-nine thousand eight hundred and thirteen pounds of water were evaporated, which gives an equivalent evaporation from and at 212 degrees of 8.93 pounds of water per pound of coal fired. Giving credit to heat taken up in superheating steam, the equivalent evaporation is increased to 9.62 pounds of water per pound of coal. The theoretical evaporation per pound of coal used during this trip was 13.63 pounds, so that the boiler efficiency for the trip was 70.6 per cent.

Run No. 10, Engine 901.—The run was made on August 8th, from La Junta to Trinidad, with a train of 1,337 tons in 49 cars. The total time on road was six hours and seven minutes, the delayed time was one hour and fifty-two minutes, so that the actual running time was four hours and fifteen minutes. The coal consumed on the run was 21,833 pounds; this performance showed a consumption of 200.3 pounds of coal per thousand gross ton miles. For a distance of 32.3 miles from Timpas to Simpson, the coal consumed was 238.7 pounds per thousand gross ton miles; 156,421 pounds of water were delivered to the boiler, so that the equivalent evaporation of water per pound of coal was 8.23. This figure was increased to 8.79 by crediting the amount of heat yielded by the waste flue gases in superheating steam. The theoretical evaporation from coal used on this trip



Run No 10 Date 8-8-09 Train Tonnage 1337 No. of Cars 49



Run No. 14 Date 8-14-09 Train Tonnage 1351 No. of Cars 57 was 13.7 pounds of water per pound of coal, so that the boiler efficiency for the trip was 64.3 per cent.

The maximum temperatures of steam to high pressure cylinders was 428 degrees, that to low pressure cylinders was 453 degrees. The maximum superheat to high pressure cylinders was 50 degrees, that to the low pressure cylinders 140 degrees. The average number degrees superheat to the high pressure cylinders was 24.4 degrees, that to the low pressure cylinders was 102.2 degrees.

All data relative to the performance of engine on this trip is graphically plotted and shown in the illustration. This chart also includes a profile of the district showing elevation in feet above sea level at different points on the road. Among other things this chart shows at different points of observation the dynamometer and indicated horsepower, the speed in miles per hour, the degrees superheat in both high and low pressure cylinders, the quality of steam, the boiler pressure, the temperatures in smoke box, etc.

The highest continuous drawbar pull exerted during this run was 39,050 pounds at a speed of ten miles per hour. At 12.8 miles per hour, the engine exerted a drawbar pull of 38,550 pounds at the back of the tender; at twenty miles per hour, a drawbar pull of 30,950 pounds was exerted.

Run No. 12, Engine 901.—The run was made from La Junta to Trinidad on August 11th with 1,328 tons contained in forty-six cars. The total time on road was seven hours and two minutes; the total delayed time was one hour and forty-four minutes, so that the actual running time was five hours and eighteen minutes. A total of 22,048 pounds of coal were fired on the trip and 158,355 pounds of water were supplied to the boiler, so that the equivalent evaporation from and at 212 degrees was 8.22 pounds of water per pound of coal. Giving credit for heat regained from waste gases in superheating steam, the equivalent evaporation is raised to 8.81 pounds of water per pound of coal, so that the boiler efficiency attained for the run is 65.8 per cent. The fuel consumed for the total run averaged 203.8 pounds of coal per thousand gross ton miles. On the heavy stretch from Timpas to Simpson, the fuel consumed averaged 250 pounds of coal per thousand gross ton miles. The boiler efficiency for this portion of the trip was 64.8 per cent. The maximum temperature attained in the high pressure steam was 422 degrees and in the low pressure steam 432 degrees. The maximum superheat in the high pressure steam was 35 degrees and in the low pressure 105 degrees. Engine gave a drawbar pull of 39,740 pounds at a speed of 12.7 miles per hour. At a speed of sixteen miles per hour, a drawbar pull of 32,490 pounds was developed, while at a speed of twenty-six miles per hour, a drawbar pull of 19,530 pounds was exerted. At mile post 617, the engine showed 1,937 indicated horsepower at twenty-six miles per hour, and developed 1,354 drawbar horsepower. This power was developed under accelerating conditions.

Run No. 13, Engine 901.—This run was was made on August 13th, with 3,166 tons contained in 59 cars. The total time on road was five hours and forty-five minutes, delayed time one hour and forty minutes, so that the actual running time was four hours and five minutes. On this run 8,300 pounds of coal were fired, so that the average consumption of coal was 32.2 pounds per thousand gross ton miles, which was the best record obtained on down grade runs.

The water supplied to the boiler amounted to 61,801 pounds. The evaporation at the dome, from and at 212 degrees, was 8.62 pounds of water per pound of coal. This evaporation was further increased, on account of heat absorbed from waste gases in superheating steam, to 9.15 pounds of water per pound of coal. The heat value of the coal used was considerably less than on previous trips. The coal itself had a theoretical evaporative value of 13.25 pounds of water per pound of coal, so that the efficiency of the boiler was 69 per cent. The maximum temperature of steam to high pressure cylinders was 408 degrees, that to low pressure cylinders was 439 degrees. The maximum superheat in high pressure steam was thirty-two degrees and that in low pressure steam was 110 degrees.

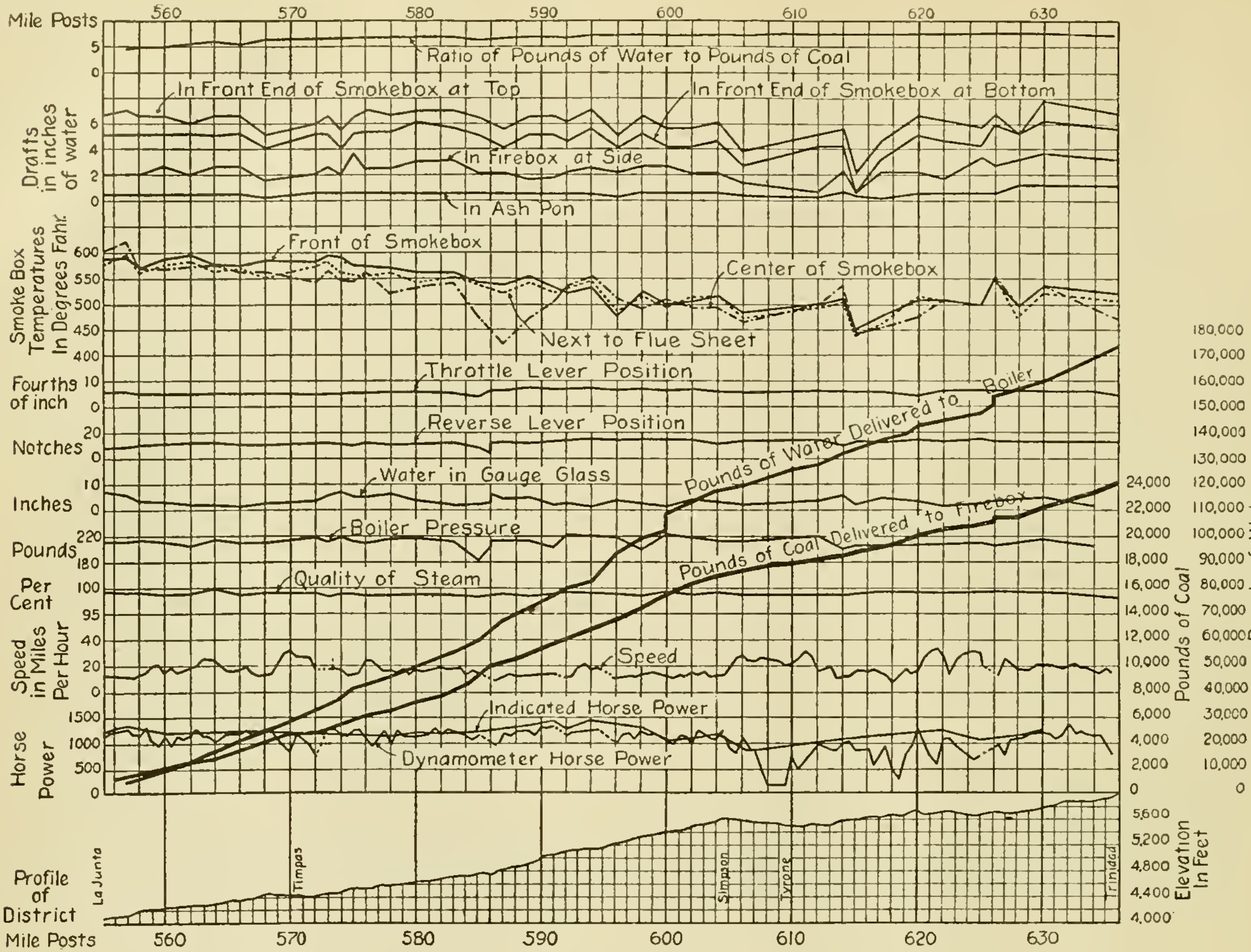
Run No. 14, Engine 901.—The run from La Junta to Trinidad was made on August 14th with 1,351 tons in fifty-seven cars. All of the previous runs of this engine were made with arch brick equipment. The principal object of this run was to determine the bearing that the arch brick equipment had on general performance and to determine the relative economy of this equipment. The coal consumption for this run was 25,511 pounds, so that the average consumption was 231.7 pounds of coal per thousand gross ton miles. The water supplied to the boiler amounted to 185,980 pounds. The evaporation from and at 212 degrees was 8.37 pounds of water per pound of coal, but this was increased to 8.89 pounds upon crediting to the boiler the amount of heat absorbed in superheating steam from the waste gases.

The maximum temperature of the steam to high pressure cylinders was 405 degrees, that to the low pressure cylinders 438 degrees. At a speed of twenty-six miles per hour the engine exerted a drawbar pull of 40,430 pounds. At a speed of 16.7 miles per hour, a drawbar pull of 28,860 pounds was recorded.

Run No. 2, Engine 923.—The run was made on August 22nd, from Trinidad to La Junta with 3,171 tons in sixty-two cars. The total time on road was seven hours and forty-two minutes, the delay was three hours, so that the actual running time was four hours and forty-two minutes. Two delays occurred during the trip on account of breaking of train equipment, one of one hour on account of a broken knuckle and one of twenty minutes on account of a drawbar pulled out. During these periods six hundred pounds of coal were fired. The total coal consumption for the run was 11,370 pounds. The average coal consumption per thousand ton miles was 44.1 pounds. The total water supplied to the boiler was 74,340 pounds. The evaporation from and at 212 degrees was 7.25 pounds of water per pound of coal. The theoretical evaporation of the coal used for the trip was 14.1 pounds of water per pound of coal, so that the boiler efficiency was 51.4 per cent. The ash in the coal as fired amounted to 1,413 pounds, while there were removed from the ashpan 1,979 pounds of ash.

Run No. 3, Engine 923.—The run was made on August 24th from La Junta to Trinidad with 1,126 tons in fifty cars. The total time on road was eight hours and fifty-five minutes, the delayed time was two hours and thirty-eight minutes, so that the actual running time for the trip was six hours and seventeen minutes. On this run, as on run number two, the engine did not have arch brick equipment. One object of the run was to determine the value and efficiency of the arch brick equipment so far as fuel consumption was concerned. The results of the run on this account are more properly compared with those obtained on run number fourteen of engine 901. The total coal consumed for the trip amounted to 26,988 pounds. The average fuel consumption per thousand ton miles was 317.2 pounds of coal, which was greatly in excess of figures obtained on any other run. The total water supplied to the boiler was 172,907 pounds. The equivalent evaporation from and at 212 degrees was 7.33 pounds of water per pound of coal. The boiler efficiency for the run was 52.2 per cent. At a speed of 12.4 miles per hour a drawbar pull of 33,350 pounds was exerted. At 16 miles per hour, the drawbar pull was 27,990 pounds; at 19.3 miles per hour, the drawbar pull was 21,080 pounds. On the territory from Timpas to Simpson 3.11 pounds of coal were burned for each million foot pounds at the drawbar, and 74,730 heat units in the coal were consumed per drynamometer horsepower per hour. These figures are considerably higher than results obtained on any other test runs.

Run No. 4, Engine 923.—The run was made August 25th from Trinidad to La Junta with 3,062 tons in 51 cars. This was the first trip by engine with arch brick equipment. The run was made in four hours and forty minutes, delayed time fifty-two minutes, so that the actual running time for the trip was three hours and forty-eight minutes. This is the shortest time made on any of the test runs. The total coal consumed for the trip was 9,390 pounds, giving an average of 37.6 pounds of coal per thousand ton miles. During the trip 64,989 pounds of water



Run No 5 Date 8-27-09 Train Tonnage 1265 No of Cars 69

were delivered to the boiler. The equivalent evaporation was 7.74 pounds of water per pound of coal. The theoretical evaporation of the coal burned for this trip as determined by analysis was 14 pounds of water per pound of coal, so that the efficiency of the boiler was 55.3 per cent. The ash in the coal as fired was 1,160 pounds, that removed from ashpan at the end of trip was 1,287 pounds. These figures show a close comparison with theoretical ash and actual ash.

Run No. 5, Engine 923.—The run was made on August 27th, with 1,265 tons in 69 cars. The total time on road was six hours and fourteen minutes. The delayed time twenty-nine minutes, so that the actual running time was five hours and forty-five minutes. This was the first run made on up grade with engine equipped with arch brick.

The total fuel consumed for the trip was 24,618 pounds of coal, or an average of 238.8 pounds of coal per thousand ton miles. This was the very best record obtained during the test with this engine on up-grade runs. On the heavy grade from Timpas to Simpson the average fuel consumption per thousand ton miles was 292.9 pounds of coal. During the trip 169,713 pounds of water were supplied to the boiler. The evaporation from and at 212 degrees was 7.82 pounds of water per pound of coal. The boiler efficiency was 52.2 per cent. On the portion of the run from Timpas to Simpson, the boiler efficiency was 56.3 per cent. The engine gave a drawbar pull of 34,220 pounds at a speed of 11.8 miles per hour, 27,650 pounds at a speed of 15.6 miles per hour, and 24,540 pounds drawbar pull at a speed of 19.6 miles per hour. All observations made during the test runs are shown on the accompanying chart.

Run No. 6, Engine 923.—This run from Trinidad to La Junta was made on August 28th with 3,101 tons in a train of sixty-five cars. The total time on road was seven hours and thirty-four minutes, total delayed time three hours and six minutes, so that the actual running time was four hours and twenty-nine minutes. The total fuel consumption for the trip was 11,635 pounds of coal, the average coal consumption for the run was 46.1 pounds per thousand ton miles. The water supplied to the boiler for the trip was 80,763 pounds. The evaporation was 6.94 pounds of water per pound of coal. The equivalent evaporation from and at 212 degrees was 7.87 pounds of water per pound of coal. This evaporation was considerably better than was made by engine on any other down grade run. The theoretical evaporation of the coal used for the trip was 13.8 pounds of water per pound of coal, so that the boiler efficiency for this trip was 57 per cent.

Run No. 7, Engine 923.—The run was made August 29th from La Junta to Trinidad with 1,176 tons in a train of sixty-four cars. The total time for the trip was six hours and fifteen minutes, the delayed time thirty-two minutes, so that the actual running time was five hours and forty-three minutes. The total coal consumed for the trip was 25,981 pounds, of which 11,968 pounds were used from Timpas to Simpson. The average fuel consumption per thousand ton miles for the entire trip was 271.2 pounds of coal, and for the run from Timpas to Simpson was 315.1 pounds of coal per thousand ton miles. The total water supplied to the boiler for the trip was 179,175 pounds, from Timpas to Simpson, 81,785 pounds. The equivalent evaporation for the trip was 7.89 pounds of water per pound of coal; from Timpas to Simpson, the equivalent evaporation was 7.87 per cent. The boiler efficiency for the trip was 56.1 per cent., and for that part of the run between Timpas and Simpson, the boiler efficiency was 57.4 per cent. At a speed of 17.3 miles per hour, a drawbar pull of 27,990 pounds was exerted; at 26 miles per hour a drawbar pull of 14,690 pounds was exerted. A maximum of 1,460 indicated horsepower was developed on this run at mile post 593; at the same time a drawbar horsepower of 1202 was developed, so that 82.3 per cent. of the power developed in the cylinders was exerted in pulling the train. The resistance of engine and tender to motion, together with frictional resistance, amounted to 258 horsepower or 17.7 per cent. The speed at this time was 18.9 miles per hour. These results were obtained on a slight momentum grade; soon after this reading was taken the speed and power dropped off.

The average results of three runs with each locomotive (Nos. 10, 12, 14 on 901, and 3, 5, 7 on 923) are given in the table below.

ENGINE NUMBER	901	923
Running time, hrs., min	5-21	5-55
Speed, M. P. H	15.7	13.8
Train tonnage	1,339	1,189
Number of cars	51	61
Lbs. of coal per thousand ton miles	211.9	275.7
Total fuel fired, lbs	23,131	25,862
Coal per hour, based on		
Total time on road	3,167	3,723
Running time	4,413	4,373
Rate of combustion, coal per hour		
Per sq. ft. grate area	75.5	74.8
Per sq. ft. heating surface	1.23	1.01
Draft, inches of water		
Top of front end	5.03	5.76
Front of flue sheet	3.53	4.20
Side of firebox	1.3	2.1
Ash pan	.63	.43
Total water supply to boiler, lbs	166,919	173,932
Steam per hour, lbs.		
From boiler, moist	31,790	29,413
To cylinders	30,844	28,344
Per sq. ft. heating surface	8.57	6.51
Pressure, lbs. per sq. in.		
Boiler	189	202
High pressure superheater	182	......
Low pressure superheater	82.3	......
Atmosphere	13.47	13.49
Quality of steam, per cent.		
At dome	98.9	98.9
High pressure exhaust	96.9	......
Temperature of steam leaving		
High pressure superheater	403.3	......
Low pressure superheater	416.3	......
Superheat, degs. Fahr.		
Leaving H. P. superheater	22.6	......
Leaving L. P. superheater	93.3	......
Coal by analysis		
Heating value, B. T. U	12,992	13,488
Dry coal fired, lbs	23,142	25,863
Combustible fired, lbs	20,124	22,722
Ash fired	3,082	3,138
Lbs. per sq. ft. grate area per hour		
Dry coal	75.5	74.6
Combustible	65.7	66.7
Ratio, total water to total coal	7.17	6.70
Equivalent evaporation from and at 212 degs. Fahr.		
Per sq. ft. heating surface per hour	10.23	7.81
Per lb. of coal	8.27	7.68
Per lb. of combustible	9.57	8.79
Crediting heat to superheater		
Per lb. of coal	8.83	......
Per lb. of combustible	9.73	......
Indicated horsepower		
H. P. cylinders	416	542
L. P. cylinders	846	643
All cylinders	1,262	1,185
Draw bar pull, lbs	24,705	24,168
Draw bar horsepower	1,001	970
Machine friction, horsepower	261	211
Machine efficiency, per cent	79.3	81.9
Locomotive efficiency	4.5	4.2
Boiler horsepower	1,135	978
Boiler efficiency, per cent	65.9	53.5

CONCLUSIONS.

A study of the results lead H. B. MacFarland, engineer of tests, who was in charge, to draw the following conclusions:

1. There is a marked decrease in coal consumption for a superheater engine. The decrease averages 20.8 per cent. per thousand ton miles for up grade runs, 11.5 per cent. for down grade runs, and 19.6 per cent. for constant hard working of engine on heavy grades.

2. There is a reduction of total water for up grade and down grade runs, also for heavy grade work with superheater engine.

3. Superheater engine uses 10 per cent. less water per hour, developing more drawbar horsepower on heavy working.

4. Superheater engine shows for heavy working, a decrease of 16.3 per cent. in coal per indicated horsepower hour.

5. Superheater engine shows for heavy working a decrease of 12.9 per cent. in dry steam per indicated horse-power hour.

6. There is a reduction in coal of 14.1 per cent. per drawbar horsepower hour in favor of superheater engine.

7. Superheater engine shows a decrease in heat units per drawbar horsepower of 17.3 per cent.

8. There is a marked increase in evaporation of superheater engine. It gave an average of 11.6 per cent. more dry steam per pound of coal than non-superheater engine.

9. Superheater engine with 16.6 per cent. less heating surface gives equivalent evaporation of 10.6 per cent. more water per square foot heating surface than non-superheater engine.

10. Superheater engine shows a boiler efficiency 7.6 per cent. greater than non-superheater engine; with credit for heat to superheater from waste gases the boiler efficiency is 15.8 per cent. greater.

11. Boiler capacity is increased because of heat recovered in superheated steam by 7.1 per cent. Boiler requirements are further decreased on account of lower water rate of engine, due to superheated steam. The resulting effect of superheating as shown by the tests is to increase the effective boiler capacity without increasing its actual capacity.

12. No difficulty was experienced in working water in steam to high pressure cylinders, as the moisture was evaporated in the superheater under all conditions. On this account the superheater engine is not liable to knock out cylinder head, or in case of compound engines to loosen the intermediate joint between high and low pressure cylinders.

13. Steam from low pressure superheater was superheated 90 to 125 degrees and supplied to cylinders at not over 450 degrees.

14. Superheat was sufficient to prevent entirely the dripping of water from cylinder cocks.

15. There was great uniformity of superheat under varying loads and rates of fuel consumption.

16. The tests show that for operation under local condition with usual side track delays that a superheater engine gives greater economy than a non-superheater engine.

17. The efficiency of the low pressure superheater is greater than that of the high pressure superheater. On this account superheating low pressure steam is more desirable than superheating high pressure steam.

18. The brick arch in the firebox gave an increase in economy of operation by decreasing the coal per thousand ton miles and by increasing the evaporation per pound of coal.

19. Superheater engine developed 20 per cent. more drawbar horsepower per square foot of heating surface than non-superheater engine.

20. Superheater engine gave for best performance ten per cent. more horsepower for same cylinder volumes than non-superheater engine.

HEATING AFTER CASE HARDENING.—We have introduced one new feature, and that is reheating the work after it has gone through the old method of case hardening. In reheating, we simply place the work in an open furnace, leaving it there sufficiently long to get a uniform and even heat. Heat up to 1,500 deg. Fahr. and cool in running water. This will add a higher percentage of hardness, and also restore all inequalities in the structure of the material. If your first case hardening has been overheated, causing the material to become brittle, careful reheating will restore or place the material in proper condition. I have often noticed case hardened material look crystalline all the way through on small articles, and be as brash or brittle as overheated and hardened tool steel. I have taken some of these same articles, properly reheated them, broken them and found the dark or gray iron fiber that was missing in the first hardening. The success of good case hardening is to harden to the desired depth, and retain in a great measure a tough and fibrous interior. This can be accomplished by reheating.—*George F. Hinkens of the Westinghouse Air Brake Company before the International Railroad Master Blacksmiths' Assn.*

SUCCESSFUL INDUSTRIAL EDUCATION.—In the broader view of solving this problem of industrial education there seems to be just one way of doing it, and that is to take the school to the boy or girl who is on the job. Statistics prove that after they have been educated in trade schools the majority do not follow the trade for which they have been prepared. The one thing we are pleading for is a combination of the school and the shop. It seems to us after a trial both of the university end and the public school end, that is the only feasible scheme.—*Prof. Schneider at the General Foremen's Convention.*

TWO NEW TOOLS FOR RAILROAD SHOPS.

Morton Manufacturing Co.

After a careful study of the general requirements of the modern railroad shop these two unique and useful tools have been designed by the manufacturers. They are unique by reason of the number of operations which they perform successfully and accurately and they have proven to be machines of unequalled capacity and advantage.

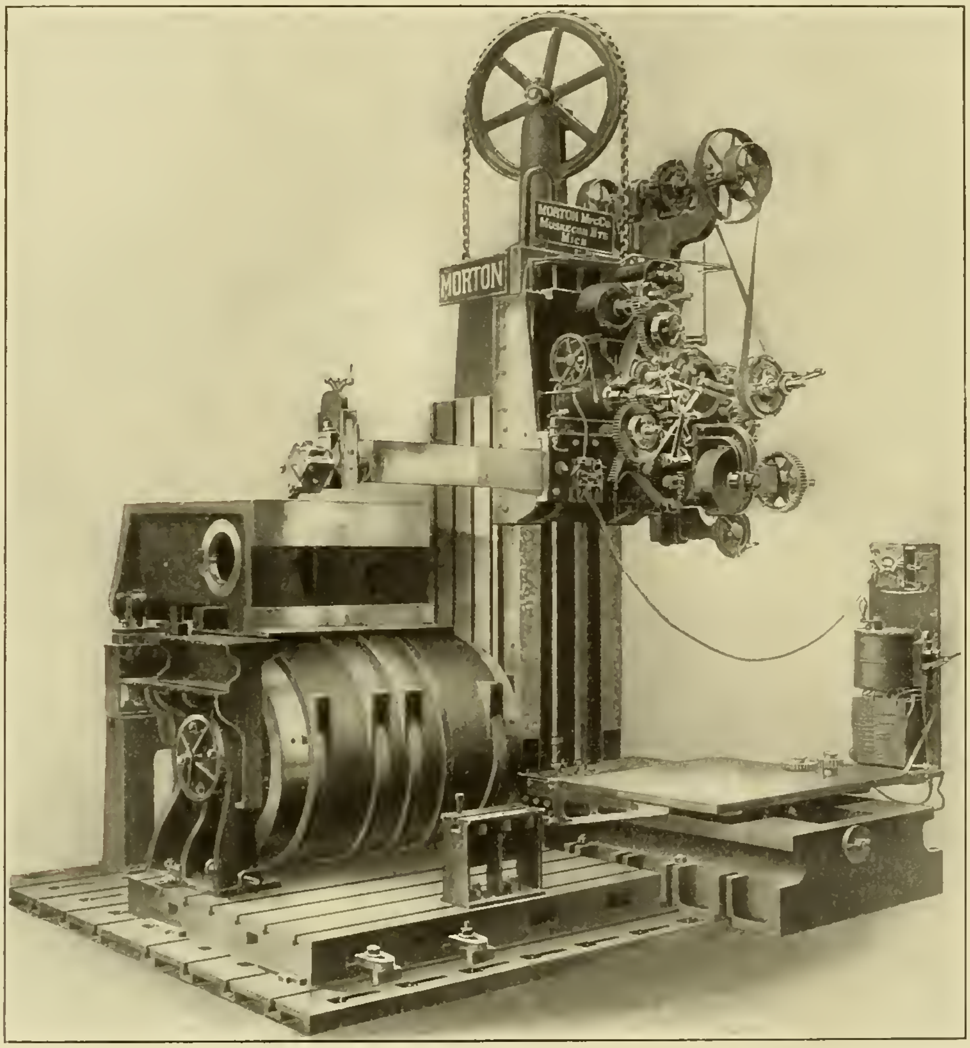
TRAVELING HEAD LOCOMOTIVE CYLINDER PLANER.

One of the most remarkable tools of its kind yet produced in this country is the new traveling head cylinder planer shown in the accompanying illustrations. It has been designed with a view to save a large amount of power and also time and labor by performing nearly all the different operations in machining cylinder castings of any size with one setting. This includes planing the sides of the casting and the valve seat, and milling the steam ports as well as boring the valve chamber in a piston valve casting.

Large bearing surfaces and square rail bearings are provided in the bed, giving a very rigid construction. The casting is heavily cross ribbed and open slots are provided on either side for securing to the floor plate, enabling the bolts to be easily removed when used as a portable machine. The column and its saddle are made in one piece, heavily constructed throughout, the T slot plate on the front column presenting a surface against which a suitable bearing may be bolted for supporting high work, thereby drawing the thrust of the cut directly against the column. The vertically moving apron is closely fitted to the column and provided with means to compensate for wear. This apron carries the feeding, cutting and other working mechanism of the machine. It has ample bearing surface to make it operate easily. The saddle casting is extended in such a manner that in connecting with the taper gibs, which are provided, it forms a bearing that insures exceptional rigidity.

Steel is used in the construction of the ram, which is made square and hollow, having a bearing on all four sides extending through the entire length of the apron. Power is applied to the ram by rack teeth being cut on the back side and having a bronze strip inserted to give a continuous bearing. The head also is made entirely of steel and screws into the end of the ram. It is graduated for planing angles and is universally adjusted, being held in position by friction.

In the design a compound, disc friction feed is used, the disc being lined on either side with vulcanized fiber. It is of the automatic relieving type and provided with instantaneous quick change. This feed can be made at either end of the valve, or at both ends where the full feed is required.



MORTON TRAVELING HEAD PLANER FOR LOCOMOTIVE CYLINDERS.

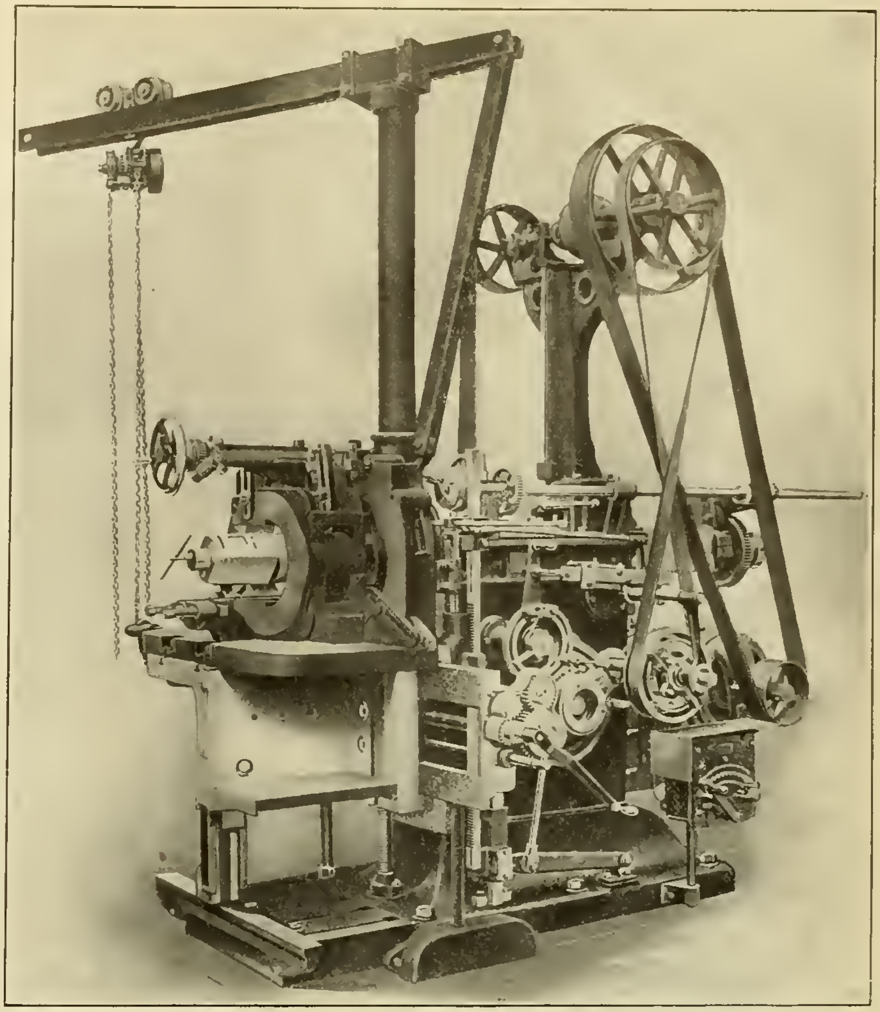
The driving power is obtained with a 10 horsepower variable speed electric motor direct attached to the base of the column, the power being transmitted through gears to a vertical spline shaft transmitting power to the attached counter shaft, which in turn carries power through belts to the friction clutch pulley, controlling the reciprocating motion. By means of the special, improved friction clutches the reversing motion is accomplished without shock or jar. A clutch is provided so that the counter shaft may be stopped and started independently of the motor, the gears being all encased and run in oil. This is a good feature as the counter shaft can be reversed for back facing and boring when necessary. This machine may be driven with a belt through an ordinary countershaft when desired, but the motor drive is more convenient for a tool of this type, and is recommended.

The counterbalance for the vertically moving apron consists of an air cylinder on the rear side of the column, to which a compressor is applied and regulated automatically when the pressure comes to a given point. This compressor is driven directly by a small motor, making it independent of any outside connection.

The column is fitted with an anti-friction device operating on a steel track and so arranged that a certain portion of the weight of the column, apron, and other mechanism, is carried, leaving only enough weight on the bearing to insure the machine working steadily. Coil springs are also provided, so that the tension may be adjusted to operate with the least power.

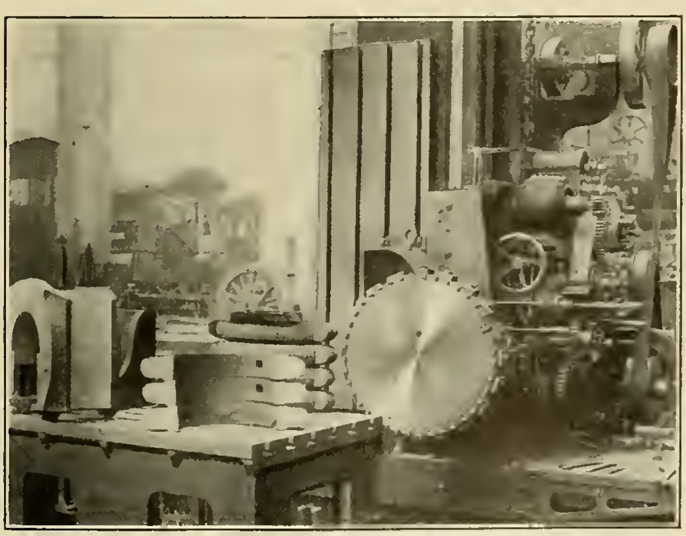
The great advantage of the cylinder chucks located on the bed plate is very evident and large castings may be rotated by this means, permitting the planing of all sides. The bed plate can be turned about on the floor plate, so that only one setting of the work is necessary after the cylinders have been bored. The chucks are of the three-jaw universal type and expand in the counter bore of the cylinder, a bolt passing through so that all surfaces are firmly secured and held in position while in operation.

With the same setting the milling of the ports is also accomplished, the port milling attachment being quickly applied to the square section of the ram without removing the shaper head. It is provided with a vertical arbor and a train of gearing, which gives it ample power. The power is applied to the spline shaft connecting with the main rotary driving mechanism for driving the internal arbor, being provided with automatic feed.



NEW 36-IN. DRAW CUT SHAPER FOR MACHINING DRIVER BOXES.

Another important feature of this machine is the milling and boring attachment, which is provided with a hollow steel arbor passing through the ram and journaled in bronze bearings of large dimensions. The front bearing is tapered and made adjustable to compensate for wear. A specially divided steel yoke is secured to the back end of the ram, which carries the journals and gearing, the main driving gears being steel. This yoke is designed so that it caps over the square section of the ram, eliminating all danger of moving. By removing three bolts the entire cap and gearing may be removed with the yoke, thus making a very quick change. The arbor has a retaining or drawing-in bolt which passes through its entire length and is provided with a forcing nut at the rear end, so that tools may be engaged or disengaged.



MORTON TRAVELING HEAD PLANER WITH ROTARY PLANING ATTACHMENT.

The feed for milling and boring consists of a special feed box secured to the vertically moving saddle and is provided with ten changes suitable for either boring or milling. Power is applied by flexible shafts and gears in the speed change box. Provision is made for reversing so that the saddle may be fed vertically in either direction, the column horizontally and the ram in or out, all these feeds being operated by means of one lever.

A table 36 in. by 8 ft. by 30 in. is provided for small work with the upper surface T slotted and provided with open slots on the lower surface. It can be used in conjunction with either the shaper or planer movements and is also of great service for work when using the rotary planing outfit, as shown in the small view. This rotary planing attachment is quickly placed in position and with it the sides of trailer boxes, eccentric straps and a great variety of other work may be machined.

The floor plate furnished with this equipment is made in two sections, each 4½ ft. wide by 13 ft. long, and is especially designed for rigidity and strength. All gears throughout the machine subjected to heavy strain are made either of bronze or steel. Below are given some of the principal dimensions of this machine:

Stroke	48 in.
Longitudinal feed	9 ft.
Vertical feed	60 in.
Feed in tool head	8 in.
Rev. of boring arbor per min., from	3½ to 42
Floor space required	14 by 16 ft.
Diameter of cylinder chucks	28 in.

SPECIAL 32-INCH DRAW CUT RAILROAD SHAPER.

This new shaper is very heavy, powerful and accurate, making it specially adapted to railroad work. In fact, it was designed after years of experience designing tools used in railroad shops and particularly with a good rate of cutting speed and a heavy cut in view.

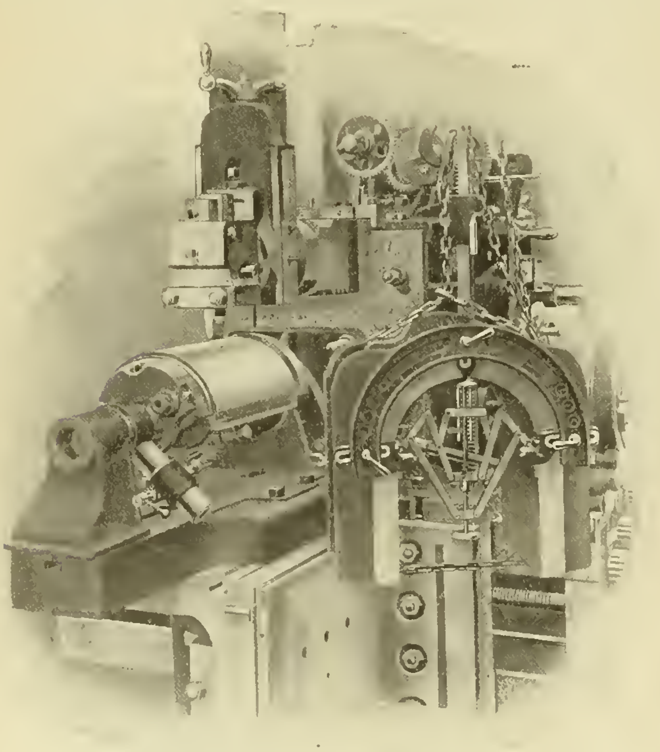
The general view shows the usual heavy and rigid construction and good design of the Morton shaper. It is provided with a rotating arbor for planing curved surfaces such as the inside of a driving box, with a rotary feed deriving its power from the regular friction through a gear and ratchet.

Box type construction is used in the column, making it very strong, and the saddle is fitted with large square rail bearings, with gibs to compensate for wear on the cross rail. It is also provided with T slots as shown. There is a small table of a special design of the angular bracket type, presenting a working surface on the top side and having a T slotted side, to which work may be secured.

The reciprocating motion of the ram is obtained by open and cross belts on either side of the machine, and instead of shifting belts, friction clutches similar to those on the large cylinder planer described above are employed. The length of stroke may be adjusted while the machine is in motion, and it can be reversed quickly at any point of the stroke by a small lever.

There is a power traverse for raising and lowering the cross rail and moving the apron or saddle horizontally for adjustment of the work, which is easily and quickly thrown in or out so that all cranking is practically eliminated. A swivel base type vise with double screws is provided and so constructed that the tendency of the work to raise on the parallel strips is largely overcome.

The main driving pinion is made from a steel forging with cut teeth of liberal proportions. It runs in oil, insuring perfect operation and minimum of wear. All the shafting is made of high grade steel and ground to size. A special sliding table is fitted to the back of the machine for the electric drive and the



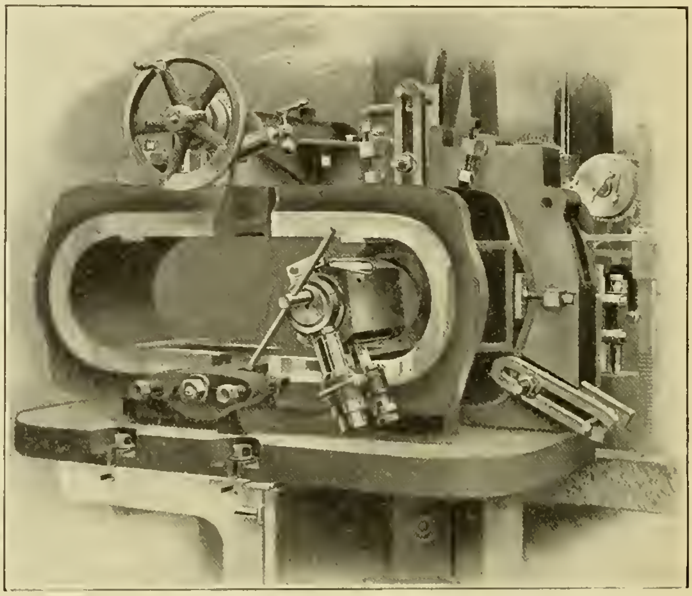
32-IN. DRAW CUT SHAPER WITH DRIVING BOX SHELL PLANING ATTACHMENT—SHOWING TEMPLATE TOOLS ON SUSPENDED BOX.

counter shaft supplied with a special friction clutch is secured to the top of the machine, so that it is not necessary to stop the motor in order to stop the machine.

A mast and trolley, as in previous designs, are built on the machine, and either a chain or air hoist can be furnished.

A special feature is the driving box shell planing attachment, which consists of the rotating chuck, as shown in one of the smaller views, and also the micrometer with scriber at the front of the chuck. The rotary feed is transmitted to the chuck through a worm gear and flexible shaft connecting with the ordinary feed mechanism. The small view shows also a suspended driving box with the template tool attached just before transferring the measurements to the shell.

The driving box slotting equipment is also very unique with the double chuck as shown in another illustration. The rotary head is used with this arrangement with an outer bearing to



32-IN. DRAW CUT SHAPER SHOWING MICROMETER ATTACHMENT.

receive the micrometer, while a line is scribed on the face of the box.

The shaper is also provided with a rod brass planing attachment designed for planing the sides and strap fit of brasses of all sizes. The various attachments make this machine very unique in that it will meet fully all railroad shop requirements, including economical and accurate work.

It is claimed that the shell or brass will have a better and more perfect bearing in the driving box because the lines of cut on both parts are parallel, eliminating the trouble of loose brasses. And the lines of cut on the journal surface of the brass will come to a good running bearing on the axle more quickly by having them parallel with the axle and running crosswise with its lines than by using the old method of machining in a lathe or on a boring mill.

Both the cylinder planer and the draw cut railroad shaper are made by the Morton Mfg. Co., Muskegon Heights, Mich.

PIECEWORK.—There is no system like piecework with the class of men we are getting to-day. You get up here and say you have 200 machinists. What do you do with them? You are spending a lot of money in looking after those machinists, but when you put the men on piecework you do not have to do so. We have an assistant general foreman who times all new operations. The men get so that the minute they get hold of a new job they look him up and say: "Come and time the new job that I have." We have never cut the price in Cleveland with the exception of where the company has spent money in buying new tools. We endeavor to be fair to the men and fair to the company. We do not work piecework on a job until the piecework schedule has been signed by five men—the assistant general foreman, the general foreman, the master mechanic, the shop specialist, and the mechanical superintendent. And the price cannot be changed without the consent of the five people that signed the cards. I do not know of a place where the price has been cut for three years.—*J. A. Boyden at the General Foremen's Convention.*

NEW ELECTRIC LOCOMOTIVE FOR THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

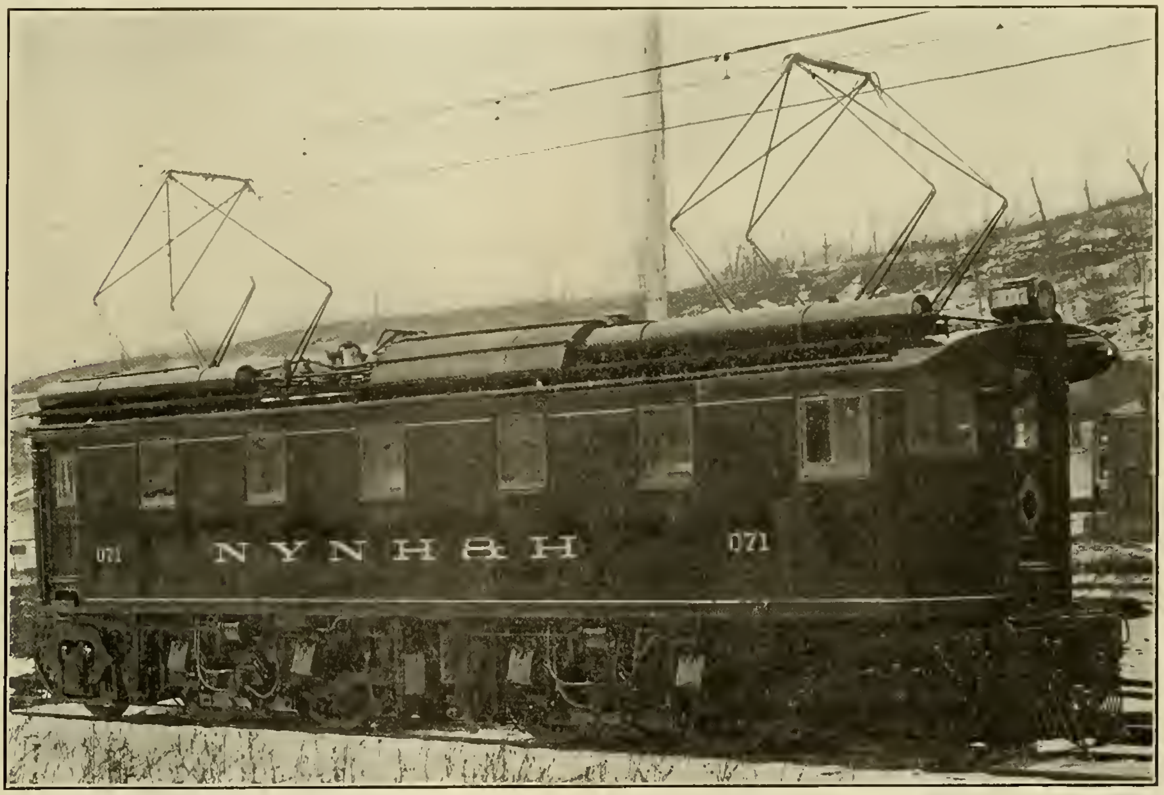
An electric locomotive of about twice the capacity of those now in use* has recently been completed by the Westinghouse Electric and Manufacturing Co. and the Baldwin Locomotive Works for the electrified section of the New Haven between New York and Stamford. This locomotive differs in many respects from the present design and was built to fill the following specifications:

To be able to haul a 1,500-ton freight train at a speed of 35 miles an hour on level track, where the train resistance is not over six pounds per ton. To be capable of hauling an 800-ton passenger train at a speed of 45 miles an hour. This capacity would enable it to haul an 800-ton limited train from the Grand Central Station, New York City, to New Haven, a distance of 73 miles with no intermediate stops, in one hour and fifty-five minutes; or to haul an 800-ton express train the same distance in two hours and twelve minutes, with an allowance of five minutes for stops; or to haul a 350-ton local train in two hours and forty-five minutes, with an average stop of forty-five seconds.

That the locomotive is an unqualified success has been demonstrated by frequent tests made under severe operating conditions, which have shown that it has a good margin over the specifications.

The design of the trucks and running gear is unique. The truck frames are connected by an intermediate draw-bar. One truck has only a rotative motion about its center-pin, while the other has a fore-and-aft, as well as a rotative motion, in order to compensate for the angular positions of the trucks and draw-bar when the locomotive is traversing a curve. The tractive force is transmitted through the truck frames and draw-bar instead of through the main frame. Each truck has two pairs of driving wheels, and a single pair of leading wheels. The wheel loads are equalized as in steam locomotive practice. To assist in reducing shocks and keeping the two trucks in alignment, chafing castings and spring buffers are interposed between the truck frames, under the center of the locomotive. The weight of the cab, instead of being carried on the center-pin, is carried on friction plates at the ends of the truck. The weight is applied through springs, which have a considerable latitude for motion to allow for variation in the track without changing materially the distribution of weight on the ends of the truck. The plan of running-gear and cab support adopted for this locomotive prevents any periodic vibration or "nosing," minimizes shocks on the truck and roadbed and insures easy riding. As the rigid wheel base is only seven feet for each truck, the locomotive is extremely flexible, and easy on the track at curves and special work.

The electrical equipment comprises four single-phase geared motors, together with the auxiliary apparatus necessary for their operation from the 11,000-volt, alternating-current or 600-volt, direct-current circuits of the electrified sections of the New Haven and the New York Central railroads respectively. The motors are of the same general electrical design as those in use on the present New Haven locomotives, the main differences being in the mechanical details and general arrangement.



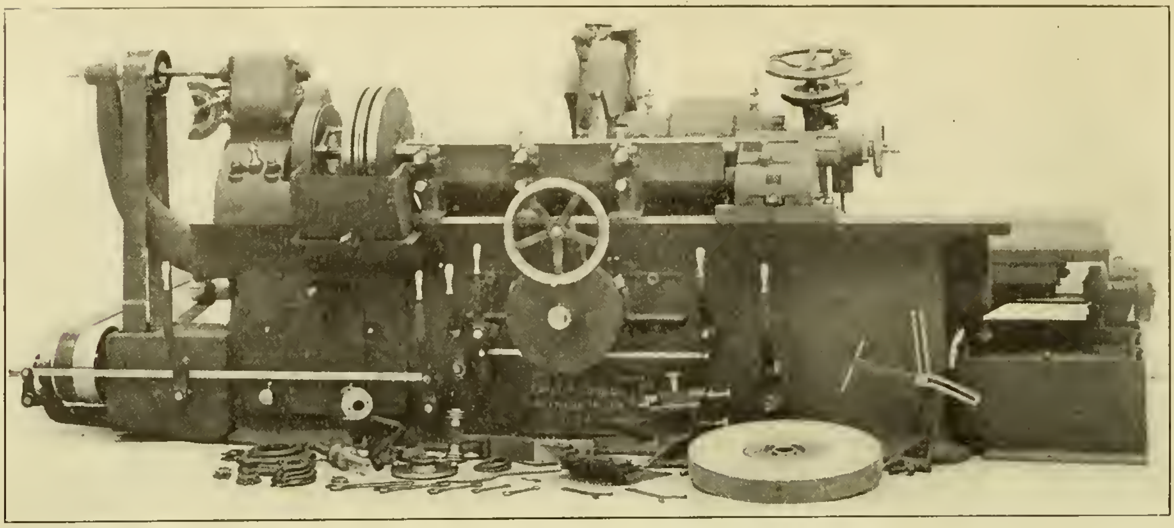
POWERFUL ELECTRIC LOCOMOTIVE FOR THE NEW YORK, NEW HAVEN AND HARTFORD R. R.

Each motor is rigidly mounted on the truck frame and directly above a quill surrounding the driving axle, to which it is geared. The motors project into the cab, and the floor above them is raised. This method of mounting the motors on the truck frame gives a high center of gravity, and prevents the transmission of strains and shocks from the track and roadbed to the motors.

An air blast transformer is provided for lowering the trolley line voltage to that required by the motors. The control apparatus is of the Westinghouse electro-pneumatic type.

When operating on alternating current, all four motors are connected in multiple, and the control is obtained by changing the connections to various voltage taps on the main transformer. On direct current the motors are first grouped all in series, and then two in series and two in parallel, in combination with various resistance steps. Provision is made for cutting out any one of the four motors singly on either alternating current or direct current. A master controller and brake valve are located in each end of the cab so that the locomotives can be operated from either end, and the system of control is such that two or more locomotives can be coupled together and operated from one master controller.

* See American Engineer, October, 1907, p. 396.



LANDIS 16" x 72" HEAVY DUTY GAP GRINDING MACHINE.

16 X 72 INCH HEAVY DUTY SELF CONTAINED GRINDING MACHINE WITH GAP.

The accompanying illustrations show a new grinding machine designed on original lines and built by the Landis Tool Co., of Waynesboro, Pa.

Throughout the entire machine it is of high power and heavy duty construction, and is specially adapted for railroad shop work, such as grinding locomotive pistons, piston valves, valve stems, crank, link, and knuckle pins, axles, etc. It is provided with a gap, as shown, so that pistons can be ground with their heads in place and also for the swing of valve yokes when grinding the stems. The gap can be located along the table to suit the work when the machine is built. The machine is of the self-contained type and is designed to be driven either by a motor or from the line shaft.

One of the views shows the arrangement of the electric drive. With either form of drive the power is applied to the main shaft at the rear of the machine, from which it is distributed and transmitted to all of the different working parts. The grinding wheel is driven from the large pulley seen in the end view, located at about the center of the machine, and mounted in a carriage rolling on the track shown extending from the base of the machine. It travels with the wheel carriage as it is traversed.

This pulley is driven by step grooves on the main shaft engaging rollers in its sleeve or hub, which makes practically a frictionless drive, as it is traversed or slides over the shaft.

The grinding wheel belt is 6 inches wide and passes over intermediate pulleys so arranged to automatically take up any change in its length and at the same time keep it under a uniform tension.

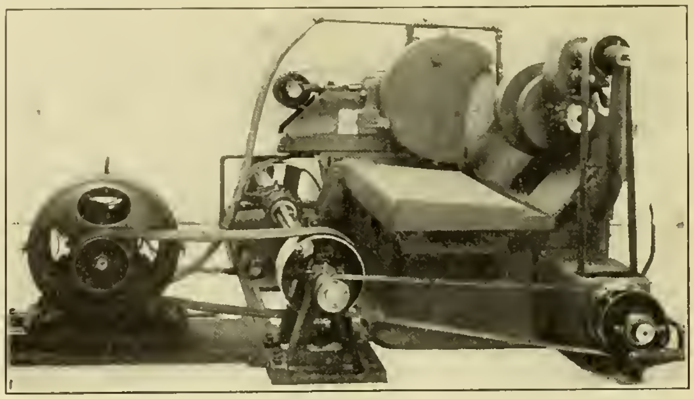
This belt has almost 200 degrees contact on both the driving and driven pulleys and its length can change about 8 inches by stretching before necessary to remove a section and shorten.

A feature that is very essential for rapid and perfect grinding is a massive and rigid grinding wheel head, such as found on this machine. The spindle of ample dimensions is made of hardened steel; the bearings are of phosphor bronze, self-aligning, and adjusted in tapers for taking up wear. They have self-oilers. The grinding wheel has provision for balancing, this being done by two weights mounted to be adjusted in a circular or annular groove in the side of the wheel collar or center.

A very powerfully geared headstock that has ample power for driving the largest piece of work that can be placed in the machine has been provided. It is arranged to give five changes of speed to the work, these being made mechanically by the movement of a single lever and by shifting a back gear in the gear box at the end of the machine another range of five speeds is obtained, making a total of ten working speeds. These speeds are indicated on a dial, shown on front view, and the changes can be made quickly and with ease. All parts of the clutch mechanism are made of hardened tool steel and all gears are finished by planing.

The work revolving and traversing mechanism are driven from the gear box at the end to which power is delivered by the belt from the main shaft. The work and traverse drives of the wheel are started and stopped together by a clutch in the pulley on the end of the gear box, operated by a lever at the front of the machine. These drives can also be operated separately and their speeds are varied independent of each other. The pump is driven from the end of the main shaft, as shown at the right of the front view.

It was suggested in an article in the April, 1909, number of this journal how the railroads could add considerably to the life of such parts as car axles, piston rods, valve stems, crank pins, etc., by grinding after they have become worn instead of turning them on a lathe. In addition to this advantage it has been demonstrated in recent railroad practice that there is a decided saving of time. For this reason the new machine is especially interesting to the railroads, leaving entirely out of consideration the superior wearing qualities of a ground surface and the consequent saving of packing and brasses.



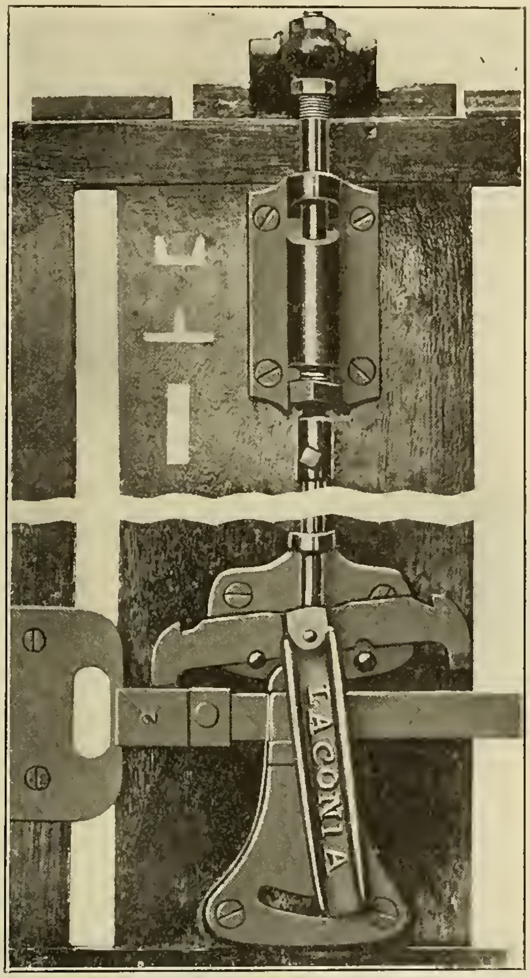
END VIEW OF 16" x 72" HEAVY DUTY GRINDER.

Following are some actual performances with this machine: A piston rod 3½ in. by 36 in. which was worn in service was ground accurately in 15 minutes without any previous turning on a lathe. The stock removed was 1-32 in. diameter. The stock removed from a valve stem 1¼ in. by 18 in. was 1-32 in. diam. in 6 minutes, and a connecting rod pin 4⅜ in. by 8⅝ in. was ground down about 1-32 in. diam. in 9 minutes. These results are examples of what can be accomplished and show the possibilities of grinding machines in railroad work.

It is announced that there will be demonstrations on these grinding machines at the master mechanics' and master car builders' convention.

SLIDING DOOR FASTENERS.

Damage to baggage or express matter, as well as injury to employees due to the sudden opening or closing of sliding doors when the brakes are quickly applied or released, is common enough to require some preventative. Recognizing this condition, W. H. Durant, air brake inspector of the Boston & Maine Railroad, has designed a spring fastener that will hold the door at any desired point and at the same time permit it to be easily



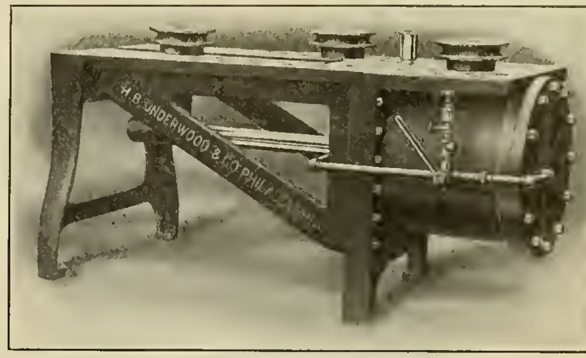
and freely opened or closed when desired. This lock is arranged to grip the track on which the door slides and is held in operation by a spring in the guide casting at the top of the door. The operating handle is located at a convenient height and swings either way. As it is pulled to one side it moves about one of the fulcrums and lifts the rod against the resistance of the spring and releases the friction at the top of the track. At the same time a wedge shape projection on the handle arm unlatches the catch that snaps into the catch plate on the jamb. When it is desired to lock the door on the inside the handle is simply locked to the catch bar. This fastener is made for both right and left handed doors and is being handled by Irving S. Elliott, Lakeport, N. H.

A NEW PIPE BENDER.

A pipe bender operated by either steam or compressed air, as desired, which has a cylinder 20 in. in diameter and is limited in power only by the pressure of the working agent, is shown in the accompanying illustration. This bender has a large table that is entirely unobstructed, the ram being underneath the table and sliding in a strongly constructed guide. The ram carries a pin extending above the table surface on which a roller of suitable size can be placed. The table is provided with numerous holes in which pins or rollers of various sizes can be placed and permit the bending of practically any desired shape.

This bender can be used to some extent as a bulldozer if desired by simply placing the dies on the ram projection and the table. Because of its power, considerable work of this character can be satisfactorily performed.

A special feature of this device is the delicate movement which can be obtained by an arrangement that provides pressure on both sides of the piston at all times. The operating valve is so constructed that only the amount of air or steam required for the actual bending is wasted; the air is transferred from one side of the piston to the other and the piston is forced forward because of the larger area on that side due to the absence of the piston rod. This feature permits the piston being moved only



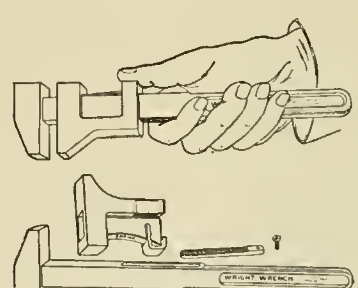
a fraction of an inch when desired, and it may be held perfectly stationary to allow for measuring or for placing templets on the work. Nicety of control of this character is very desirable, particularly for straightening work.

This machine is manufactured by H. B. Underwood & Co., Philadelphia, Pa.

A NEW ADJUSTABLE WRENCH.

A new wrench of novel construction has recently been placed upon the market by the Wright Wrench and Forging Co., Canton, O., and will be demonstrated at the coming Master Mechanics' and Master Car Builders' conventions. It will be seen, by referring to the illustration, that it consists of a combined upper jaw and handle, a lower or sliding jaw, an adjustment spring and a steel rack set into the lower face of the handle. By taking the wrench as shown in the illustration a slight pressure of the thumb will depress the movable jaw against the resistance of the spring and release its engagement with the rack. It can then be opened or closed as desired, when the release of the pressure causes it to again engage the rack.

On all wrenches up to 12 in. the adjustment is within .04 of an

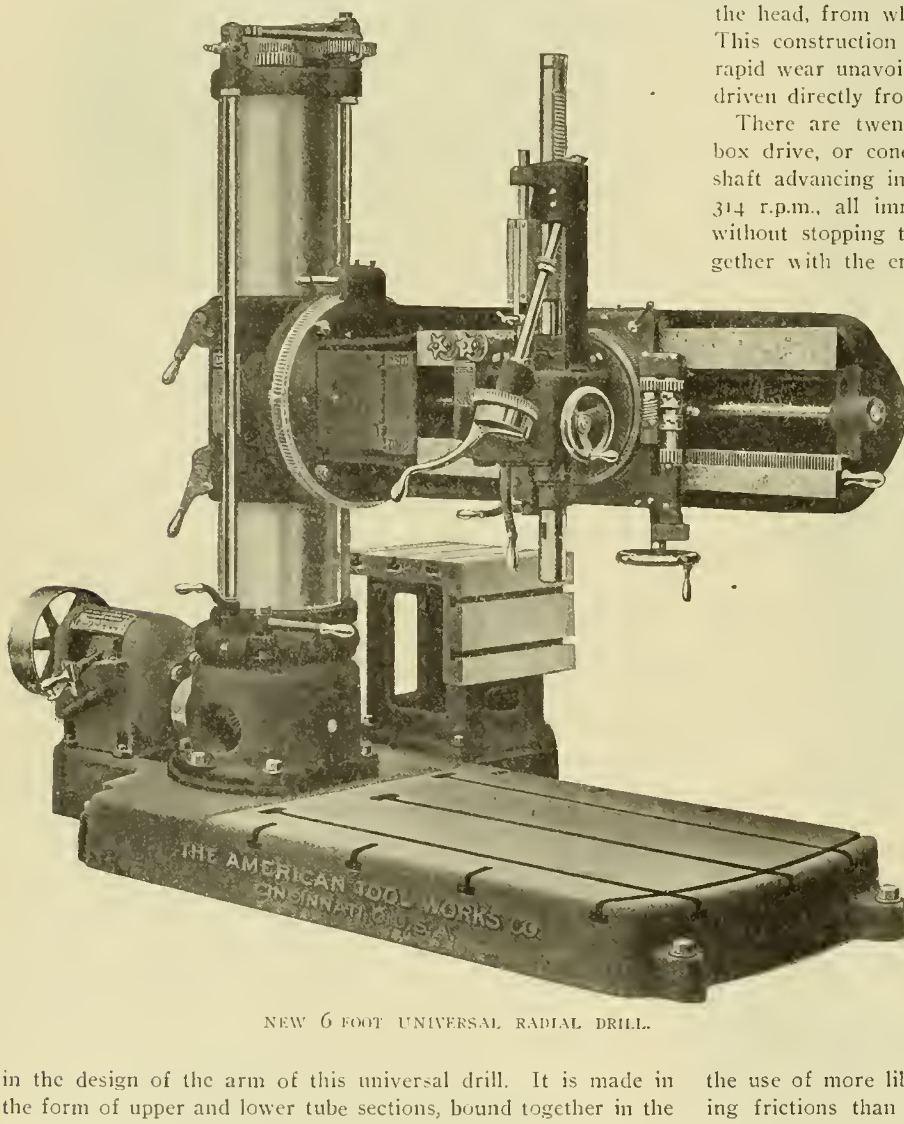


inch and on the 15 in. and 18 in. sizes within 1/16 of an inch. The wrench is substantially built of carbonized steel, and is ground and polished. It is claimed that these wrenches have no back lash, and that they will not under any circumstances become locked on a nut. They are very quickly adjusted and can be used in either hand.

NEW FULL UNIVERSAL TRIPLE GEARED RADIAL DRILL.

The universal radial drill has heretofore proven entirely inadequate to the severe duty imposed upon the modern plain arm radial, but its field of usefulness in machine shops is so large that a redesign was imperative. Up to the present time the universal radial has been incapable of driving to the limit high speed steel drills, principally because of lack of power and springing of the arm. The new machine shown in the accompanying view represents a radical departure in design and the highest development in this type of drill, which fulfills all the requirements in power and rigidity. It shows the result of careful consideration and in its design there are incorporated the many excellent features of the plain radial.

Every weakness heretofore encountered has been eliminated in the design of the arm of this universal drill. It is made in the form of upper and lower tube sections, bound together in the back by a double wall of metal and further reinforced by transverse ribbing. On the front wall ways are formed for carrying the unusually wide and rigid saddle, which is firmly locked at any point along the arm by means of a powerful clamping device. The arm is also clamped to the column by two small levers, which obviates loose wrenches. It is raised and lowered rapidly by a double thread, coarse pitch screw hung on ball bearings and controlled by a convenient lever which cannot be operated until slightly raised from its bearing, thus guarding against accident due to unintentional movement while the arm is clamped to the column. The arm is rotated in a complete circle by means of a worm engaging wheel cut in the periphery of the arm flange. This movement, in connection with the swiveling head, permits drilling and tapping at any angle radiating from the center of a sphere and is firmly clamped, as set, by four large binder bolts.



NEW 6 FOOT UNIVERSAL RADIAL DRILL.

Powerful steel triple gears are used in the head, making the design very compact. It may be swiveled through a complete circle by means of a hand wheel and worm, which feature is of special value in setting the spindle for angular drilling. The worm holds the head in any position and eliminates all possibility of accident through the head swinging around of its own weight when the clamping bolts are loosened. The hand wheel also affords quicker motion than the use of a wrench. The head is moved rapidly along the arm by means of multiple gearing and rack, through the same hand wheel which operates the head, by simply engaging the clutch shown in the illustration. A feature of great merit is found in the power transmitting elements between the arm shaft and the spindle. The saddle shaft, which forms part of this connection, is offset to one side of the spindle and mounted in two long bearings, one of which is integral with the saddle and the other with the swiveling head. Power is transmitted from the saddle shaft through mitre gears to a shaft in the head, from which the spindle is driven through spur gears. This construction eliminates the consequent loss of power and rapid wear unavoidable in a universal drill, where the spindle is driven directly from the arm shaft.

There are twenty-four changes of spindle speed with speed box drive, or cone pulley drive, with a double friction counter shaft advancing in geometrical progression, ranging from 19 to 314 r.p.m., all immediately available, by means of two levers, without stopping the machine. This wide range of speeds, together with the enormous power and rigidity, render this drill equally efficient when using either the ordinary carbon or high speed twist drills and particularly fits it for a wide range of tapping requirements.

The feeding mechanism, located on the head, provides eight rates of positive geared feed, covering a range in geometrical progression from .006 in. to .060 in. per revolution of the spindle. This mechanism is controlled by two dials, with the respective feeds indicated on the face. The rate of feed being used is plainly indicated at all times and reference to the index plates is unnecessary.

The drill is provided with a depth gauge and automatic trip of greatly improved and simplified design, which will trip a spindle at any predetermined depth. The tripping mechanism is so arranged that the spindle will be tripped at any point within the limit of travel by merely setting the trip dog so that the scale reads the depth to be drilled.

Another very good feature is the tapping mechanism, which is mounted on the girdle portion of the arm between the triple gears and the speed box. This construction has a distinct advantage over the usual design of universal drills where the tapping attachment is incorporated in the saddle mechanism, as it permits the use of more liberal proportions in the design of the reversing frictions than is otherwise possible. The frictions in the tapping attachment of this machine are of the double band type consisting of an internal expanding and an external contracting friction all in one. There is perhaps no one feature in the machine which is more responsible for the enormous pulling power than this double band friction, since the power of a radial drill is not dependent upon the size of the gearing and mechanism, but rests entirely with the capacity of the frictions, and the power that can be transmitted to the twist drill is only equal to the slipping point of the friction. It is claimed that the 6 ft. size of this machine will pull an 8 in. pipe tap.

The column is of the double tubular type, the sleeve or outer column revolving on conical roller bearings which are hardened and ground. It may be clamped in any position by means of a V clamping ring. This construction is practically equivalent to a double column and affords very exceptional rigidity.

A motor drive may be attached either by a direct connection or by means of gears or belting, using a motor of any type; however a motor on the base connected by a gear to the speed box would be the most simple and efficient method.

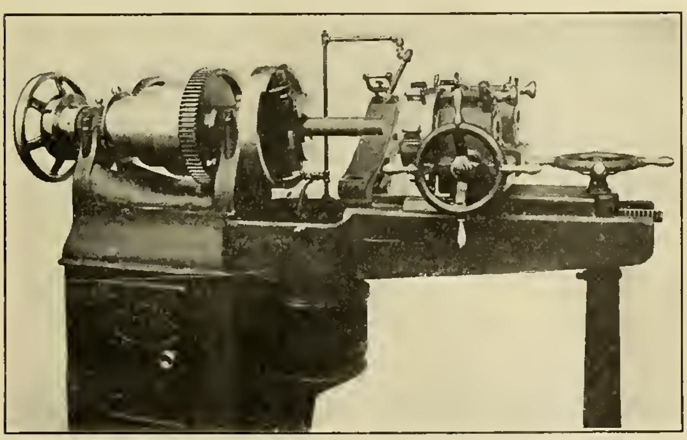
This machine is an entirely new development in the field of radial drills, being exceptionally rigid and powerful, accurate in its alignment, and at the same time arranged to be operated with the greatest ease. It is built by the American Tool Works Co., of Cincinnati, Ohio, in 4, 5, 6 and 7 ft. arm sizes.

COMBINED BOLT CUTTER, NUT TAPPER, PIPE THREADER AND CUTTING-OFF MACHINE.

ESPECIALLY ADAPTED FOR ROUNDHOUSE AND ERECTING SHOP PURPOSES.

Recently, in the presence of a representative of this journal, the bolt cutter shown in the accompanying illustrations threaded ten bolts of the following sizes: ¼, 5/16, ⅜, 7/16, ½, 9/16, ⅝, ¾, ⅞ and 1 in. in ten minutes. The same machine ran a thread 6½ in. long on a 1-in. bolt, taking but one minute from the time the workman picked up the stock until the finished bolt was removed from the machine. It also cut a thread on steel pipe of the following sizes: ¼, ⅜, ½, ¾, 1, 1¼, 1½ and 2 in. in fifteen minutes, taking but a little over one minute to replace the die heads for cutting bolts with those for pipe threading. Ten 1-in. bolts were threaded for a distance of 1⅞ in. in six minutes and 30 seconds.

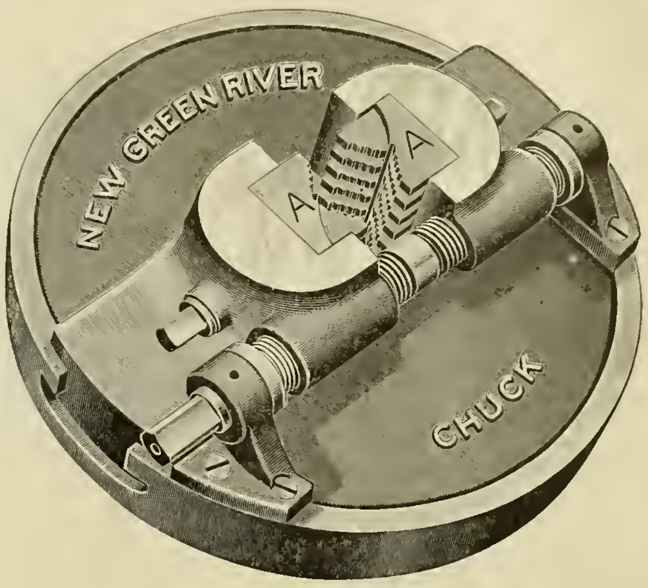
In performing this work the machine was not operated by an expert and was set up temporarily on the shop floor, no special arrangements being made to obtain remarkably high speeds, and the secret of the excellent performance made lies in the design and construction of the machine itself, particularly in the arrangement of the dies on two circular heads, so constructed as to make it possible to obtain practically any size from one-quarter inch to one inch almost instantly without any adjustment or maneuvering. On another pair of heads, that can be substituted in less than a minute, dies for larger bolts or for pipe can be obtained.



GREEN RIVER BOLT AND PIPE CUTTER.

The machine consists of a head stock with a three step cone pulley and fitted with back gears, which drives a special design of chuck that is rapid in operation and positive in its grip. The arrangement of this chuck is shown in one of the illustrations. The spindle is made hollow so that any length of pipe or bolt can be cut. On the bed is a carriage operated by means of a rack and wheel, which carries the frames for the die heads, these being connected to a double threaded shaft, are rapidly opened or closed by means of a hand wheel in the front of the machine. Each of the die heads is accurately fitted into its support and is held in place by a set screw working in a V-shaped slot, which when tightened draws it to a secure bearing against the face of the carriers. A spring pin drops into an opening and prevents the die heads from turning when the dies are in their proper position. By loosening up the set screw and pulling back the pin the heads can be revolved and bring any size die desired quickly into working position. The heads are marked at the top with the size die which is in position for cutting.

Each pair of dies has independent stop pins controlling its cut. These can be shortened or lengthened as desired to give the proper diameter of thread. One of the illustrations shows a pair of the dies removed from the cutter head. They are made of



CHUCK FOR BOLT AND PIPE CUTTER.

the very best steel and are most carefully fitted into the circular heads, being held in place by three screws, one of which engages in spot hole on the die, the other two acting as clamps. The dies are made in pairs, each being properly marked and it is a very simple matter to replace them.

The machine is provided with a centrifugal oil pump, the lubricant draining through a screen into a tank below the bed of the machine, from which it is again pumped to the cutters.

A cutting off device is applied which can be swung back out of the way when not in use. This consists of a small carriage with a tool post and a hand operated cross feed.

In using this machine for nut tapping it is only necessary to clamp a tap in the chuck and place the nut in the jaws provided between the carriers that support the die heads and run the carriage up the same as when threading a bolt. It is not necessary to remove the die heads in order to tap a nut.

For roundhouse work this machine offers many advantages. It is also well suited for work in connection with the erecting shop, where it may be desired to quickly thread bolts or to chase a thread that has been damaged. With three sets of heads a machine is provided which will thread all practical size bolts from one-quarter to 2 in. as well as piping between the same sizes. The machine is rugged and will stand hard usage and where odd or various sized threading is to be done it will prove an excellent investment.

It is manufactured by The Wiley & Russell Mfg. Co., Greenfield, Mass.

JAMES R. PATERSON died of pneumonia at his residence, 191 North Avenue, Cranford, N. J., on May 31. Mr. Paterson, or "Pat" as he was so familiarly known among his friends, entered the service of the Angus Sinclair Co. in 1895, but recently severed his connection with that company to accept a position with the Commercial Acetylene Company, 80 Broad Street, New York, and was attending the Air Brake Convention held in Detroit, Mich., when he was taken ill. Mr. Paterson was one of the most popular men connected with a railroad paper and his genial smile will be missed not only by his close personal friends, but also at the June conventions, where he was always a prominent figure. Good, big-hearted "Pat," with a smile and a handshake of welcome for all he met or knew, was the kind of man not easy to forget.

SUMMERS MOTOR DRIVEN ORE CAR.

Two Summers ore cars of the same type as described on page 49 of the February and page 338 of the August, 1909, issues of this journal have recently been equipped with motor trucks and complete electrical equipment for their propulsion and control.

These cars were designed for hauling copper ore from a cableway terminal to storage bins over a 1¼ per cent. grade, with an estimated maximum speed of 8.5 miles per hour.

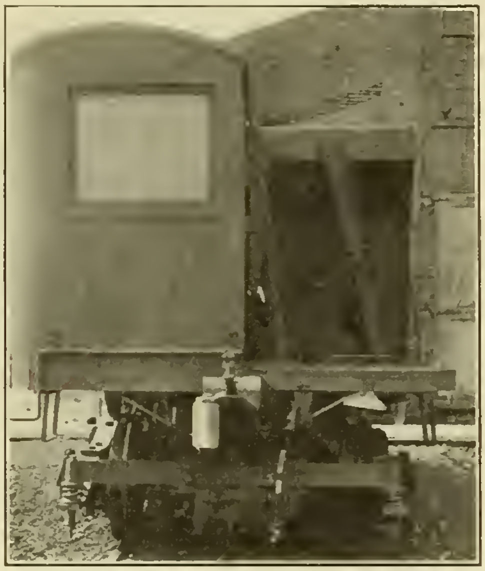
As the haul is of comparatively short length, the car will dump often, and particular attention has been paid to facilitate the easy operation of the doors; these are operated by a crank conveniently located on the end platform, connecting, by means of an endless steel chain to suitable gearing, one man only being needed to run each car and operate the doors at the storage bins.

The electrical equipment consists of two 35 horsepower type K 101 Westinghouse 500 volt, series RW type motors, mounted one on each truck and geared 14 to 79. One series-parallel controller, the necessary resistance grids, circuit breaker, etc., are all conveniently located in the cab. Current will be collected from a trolley wire located about 22 feet above the tracks, with rail return.

A powerful hand brake, with shoes on all wheels, form the brake arrangement of the car.

These units will each handle approximately 30 cubic yards of ore per trip and the dumping operation requires somewhat under a minute at the bins, which would indicate that the equipment would prove highly efficient. It is reported that even during the

SUMMERS ELECTRIC ORE CAR.



END VIEW OF ELECTRIC ORE CAR.

coldest weather this type of car, in the service of the ore carrying roads in the Northwest, after the 70 mile run from the mines to the docks, dumps its load without the usual delays incident to frozen ore.

BOOK NOTES.

Practice and Theory of the Indicator. Third edition. By Stricklan L. Kneass. 171 pages. Illustrated. Published by John Wiley & Sons, New York. Price, $1.50.

Since the publication of the second edition of this book two years ago there have been marked changes in the construction of locomotives, which have reacted upon the methods of feeding boilers and consequently upon the indicator design. The trend is now toward the non-lifting form of injectors and feed water heating is becoming popular, therefore this well-known book has been thoroughly revised and additional chapters and sections have been incorporated to bring it strictly up to date It deals most thoroughly with the theory of the injector, particularly as applied to locomotives. A chapter has been incorporated on feed water heating and the practice of handling injectors is very thoroughly considered.

"Electric Traction on Railways." By Philip Dawson, M. I. E. E., M. I. M. E. Handsomely and substantially bound in half leather. 855 pages, 6 x 9¼ in. Fully illustrated. Published by "The Electrician Co.," London. American agents, D. Van Nostrand Co., 23 Murray street, New York. Price, $9.00 net.

This book is an exhaustive treatise on the subject and goes fully into the advantages of the various systems of electrification and also the development of electric traction in England and in this country. It also fully discusses trolleys and methods of suspension, third rail systems and power and sub-stations. Thirty-seven pages are devoted to "Financial Considerations," giving careful comparisons of the working costs of steam and electric railroads, including maintenance of equipment and fuel, with data obtained from leading English and American railroads.

PERSONALS.

Frank Rush has been made district master mechanic of the Chicago, Milwaukee & Puget Sound Railway on the division west of Avery.

E. H. Spenger has been made assistant superintendent of motive power of the Butte, Anaconda & Pacific Railway, with office at Anaconda, Mont.

G. W. French has been appointed master mechanic of the St. Louis, Iron Mountain & Southern Ry. at Ferriday, La., vice R. L. Butler, transferred.

A. V. Manchester has been made district master mechanic of the Chicago, Milwaukee & Puget Sound Ry., with jurisdiction east of Harlowtown.

W. B. Lipscomb, foreman locomotive repairs at Selma, Ala., has been appointed master mechanic of the Southern Railway at Charleston, succeeding Mr. Kadie, transferred.

A. R. Ayers, asst. master mechanic of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind., has been promoted to mechanical engineer to succeed Mr. Kendig, promoted.

L. B. Rhodes, master mechanic of the Georgia, Southern & Florida Railway, has resigned and that position is abolished.

C. H. Terrell, master mechanic of the Chesapeake & Ohio Ry. at Huntington, W. Va., has been appointed superintendent of motive power of the West Virginia general division.

W. F. Kaderly, master mechanic of the Southern Railway, has been appointed superintendent of motive power of the Georgia, Southern & Florida Railway, with office at Macon, Ga.

J. R. Gould, master mechanic of the Chesapeake & Ohio Ry. at Richmond, Va., has been appointed superintendent of motive power of the Virginia general division at the same place.

J. F. Walsh, superintendent motive power of the Chesapeake & Ohio Ry. at Richmond, Va., has been appointed general superintendent of motive power, with offices at the same place.

W. T. Smith, master mechanic of the Chesapeake & Ohio Ry. at Covington, Ky., has been appointed superintendent of motive power of the Kentucky general division, with office at Covington.

J. T. Carroll, master mechanic of the Lake Erie & Western R. R. at Tipton, Ind., has been appointed superintendent of motive power of the Baltimore & Ohio R. R., with office at Pittsburgh, Pa.

T. H. Goodnow, master car builder of the Lake Shore & Michigan Southern Ry. at Englewood, Ill., has been transferred to asst. master mechanic at Elkhart, Ind., vice A. R. Ayers, promoted.

W. P. Hobson, master mechanic of the Chesapeake & Ohio Ry. at Lexington, Ky., has been appointed master mechanic of the Cincinnati division at Covington, Ky., succeeding W. T. Smith, promoted.

H. G. Griffin, general shop inspector of the Lake Shore & Michigan Southern Ry. at Collinwood, has been promoted to supervisor of materials and coal, at Cleveland, vice J. W. Senger, transferred.

E. A. Murray, foreman machine department at Covington, has been appointed master mechanic on the Ashland division of the Chesapeake & Ohio Ry. at Lexington, Ky., succeeding Mr. Hobson, transferred.

B. H. Montgomery, asst. general foreman of the Collinwood shops on the Lake Shore & Michigan Southern Ry., has been promoted to general foreman locomotive shops, succeeding B. F. Kuhn, promoted.

B. F. Kuhn, general foreman locomotive shops of the Lake Shore & Michigan Southern Ry at Collinwood, Ohio, has been promoted to asst. superintendent Collinwood shops, vice F. H. Reagan, promoted.

A. J. Isaacks, master mechanic of the Chicago Great Western Ry. at Clarion, Iowa, has been appointed master mechanic of the southern division with headquarters at Des Moines, Ia., succeeding T. H. Yorke, resigned.

F. H. Reagan, asst. superintendent at Collinwood shops of the L. S. & M. S. Ry., has been promoted to master mechanic of the Lake Erie & Western R. R., with headquarters at Tipton, Ind., vice J. T. Carroll, resigned.

J. W. Senger, supervisor of materials and coal of the Lake Shore & Michigan Southern Ry. at Cleveland, has been promoted to master car builder, with headquarters at Englewood, Ill., vice Mr. Goodnow, transferred.

T. J. Hamilton has been made district master mechanic of the Chicago, Milwaukee & Puget Sound Railway, in charge of line from Harlowtown, Mont., to Avery, Ida.

J. W. Johnson, general foreman at Oelwein, Ia., has been appointed master mechanic of the Western division of the Chicago Great Western Ry., with headquarters at Clarion, Ia., succeeding Mr. Isaacks, promoted.

James S. Sheafe has been appointed engineer of tests of the Illinois Central R. R., the Indianapolis Southern R. R., and the Yazoo & Mississippi Valley R. R., with headquarters at the Burnside shops, Chicago, reporting to the general superintendent of motive power.

C. M. Hoffman, master mechanic of the Denver & Rio Grande R. R. at Grand Junction, Colo., has been appointed assistant superintendent of the Idaho division of the Oregon Short Line, in charge of motive power, with headquarters at Pocatello, Idaho, vice A. H. Gairns, resigned.

R. B. Kendig, mechanical engineer of the Lake Shore & Michigan Southern Ry. at Cleveland, has been promoted to general mechanical engineer of the New York Central Lines, with headquarters at Grand Central Terminal, New York, effective June 1st, succeeding Mr. Whyte, resigned.

D. R. MacBain, assistant superintendent of motive power of the New York Central & Hudson River R. R. at Albany, N. Y., has been appointed superintendent of motive power of the Lake Shore & Michigan Southern Ry., with office at Cleveland, Ohio, succeeding Le Grand Parish, whose resignation was announced in the last issue.

John H. Converse, president of the Baldwin Locomotive Works, died suddenly from heart disease at his suburban home in Rosemont, near Philadelphia, May 3. He was born in Burlington, Vt., in 1840, and was graduated from the University of Vermont in 1861, having become an expert in mechanical drawing and stenography. Mr. Converse entered the employ of the Chicago & Northwestern Ry. Co., and remained in Chicago for two years, until at the instance of E. H. Williams he entered the service of the Pennslyvania R. R. in Philadelphia. Later he became allied with Mr. Williams in the control of the Baldwin Locomotive Works, and when the latter retired from active direction of the company Mr. Converse took it up and carried it on with great success. Mr. Converse was also a well-known philanthropist, and it is estimated that he has given $500,000 to various charitable and public institutions. At the time of his death Mr. Converse was sixty-nine years of age.

Frederic M. Whyte, general mechanical engineer of the New York Central & Hudson River R. R., has resigned and will become general manager of the New York Air Brake Co., effective June 1. Mr. Whyte was born March 3, 1865, and entered railway service May 1, 1889, since which he has been consecutively to Jan. 1, 1890, draftsman motive power department Lake Shore & Michigan Southern Ry.; Jan. 1, 1890, to Feb. 1, 1892, testing department and drawing room Baltimore & Ohio R. R. at Baltimore; Feb. 1, 1892, to June, 1892, special testing work Mexican Central Ry., Mexico City; June, 1892, to December, 1894, general railroad engineering in Chicago, chiefly with South Side Elevated road and in railway newspaper work; July, 1895, to September, 1896, draftsman Northwestern Elevated road, Chicago; September, 1896, to July 1, 1897, consulting engineer, Chicago; July 1, 1897, to Aug. 10, 1899, mechanical engineer Chicago & Northwestern Ry. and secretary of the Western Railway Club; Aug. 16, 1889, to Nov. 1, 1904, mechanical engineer New York Central & Hudson River R. R.: Nov. 1, 1904, to date, general mechanical engineer same road, Lake Shore & Michigan Southern Ry., Boston & Albany, Lake Erie & Western, Indiana, Illinois & Iowa roads, and Rutland Railroad.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

ROOFING.—The H. W. Johns-Manville Co., 100 William St., New York City, has just issued a folder describing its J. M. asbestos fireproof roofing.

LIFTING JACKS.—An illustrated catalog is being sent out by the Joyce-Cridland Co., Dayton, O., describing its new hydraulic, ratchet and gear jacks up to 50 tons capacity.

FILING CASES.—A leaflet has recently been issued by the O. M. Edwards Co., of Syracuse, N. Y., which describes the "Paownyc" steel specialties, including some very practical and neat filing cabinets and other office furniture.

MORSE SILENT RUNNING CHAIN.—General bulletin No. 9 has been issued by the Morse Chain Company, Ithaca, N. Y., describing a variety of silent chain drives for transmitting from 3 to 1,000 h.p. This bulletin is thoroughly illustrated.

BELTING.—The Graton & Knight Mfg. Co., of Worcester, Mass., has recently issued a neat little folder showing its leather belting and leather packings. This company has had 54 years' experience in the leather manufacturing business.

LOCOMOTIVE BELLS.—A leaflet has recently been issued by the Vanadium Metals Company, Frick Bldg., Pittsburgh, which gives illustrations and a report of comparative tests demonstrating the superiority of Victor-Vanadium bronze bells.

RADIAL TRAILING TRUCK.—Bulletin No. 1003, issued by the American Locomotive Company, 30 Church St., New York City, describes the latest construction of radial trailing truck with outside bearings and illustrates its application to locomotives of the 4-6-2, 2-6-2 and 2-8-2 type.

BRONZE JOURNAL BEARINGS.—The Chicago Bearing Metal Co., Chicago, Ill., is sending out the No. 2 issue of "The Graphose Age," published every once in a while. It is a small 18-page publication containing some original philosophy and also exploiting Graphose Bronze for bearings.

CONVEYING MACHINERY.—The Jeffrey Mfg. Co. is issuing a small booklet No. 38, illustrating its various types of conveyors and showing the wide range of application. It also contains an index, giving numbers of special booklets describing the application of the Jeffrey methods to the different lines of industry.

ENGINE AND TURRET LATHES.—The Lodge & Shipley Machine Tool Co., Cincinnati, O., has issued general catalog No. 21, describing all its various new machine tools. The catalog presents a very artistic appearance, and is fully illustrated, showing clearly all the details of the new patent head lathes.

EMERGENCY AND RELEASE VALVES.—Bulletin No. 389, recently issued by the National Brake and Electric Company, Milwaukee, Wis., describes the National emergency and variable release valves. This bulletin also contains some good line drawings, showing the National air brake equipment for a motor car and trailer.

MACHINE SHOP TOOLS.—The Morse Twist Drill & Machine Co., New Bedford, Mass., has just issued a very complete catalogue for 1910 describing its new twist drills, taps, dies and cutters of all descriptions. This company is also sending out a very neat and useful little booklet entitled "The Young Machinist's Practical Guide."

WATER SOFTENER.—The Dodge Mfg. Co., Mishawaka, Ind., have recently issued a poster with a colored sectional view of the "Eureka" continuous and automatic water softener and purifier. This chart presents a very attractive appearance and illustrates clearly by means of the colors the complete process employed in the Eureka method of water softening.

TILTING CRUCIBLE MELTING FURNACE.—A very interesting pamphlet, entitled "Bulletin M," has been issued by the Rockwell Furnace Co., 26 Cortlandt St., New York. It describes a furnace for melting brass, aluminum, iron, etc., mounted on a strong frame by means of trunnions, and using oil or gas fuel. This furnace has many advantages which make it suitable for melting scrap brass liners in railroad work.

DEAN BOILER TUBE CLEANER.—A very complete series of tests made by Professor Kavanaugh, of the University of Minnesota, on the Dean boiler tube cleaner, is being issued in pamphlet form by William B. Pierce Co., 327 Washington St., Buffalo, N. Y. These tests were made with great care and accuracy and developed some very interesting results in connection with the cleaning of boiler tubes. Copies can be obtained upon request.

ELECTRIC HOISTS.—The Sprague Electric Co., 527 W. 34th St., New York City, has issued a 24-page catalog describing its labor-saving electric hoists, which can be used out of doors as well as inside for every purpose. The general catalog of this company, containing 200 pages, shows all the designs necessary to fill the various requirements, including railway machine shops and power plants. A small catalog illustrating the Sprague Flexible steel armoured hose is also being issued by the same company.

COLBURN BORING MILLS.—Rugged and powerful machines, built to withstand the heaviest cuts with high speed steel, and embodying many improvements for the rapid production of work, are shown in a catalog recently issued by the Colburn Machine Tool Co., Franklin, Pa. This catalog is confined to the new model boring and turning mill. It contains many photographs showing details of construction, each part being fully described. It forms most interesting reading and will be found to be of value to any shop superintendent or foreman.

GAS ELECTRIC MOTOR CAR.—The General Electric Company, Schenectady, N. Y., has recently issued a very attractive pamphlet, numbered 4730, describing a single truck type of gas electric car. The equipment consists of a direct coupled gas engine and generator with an exciter upon the same shaft, all completely enclosed and mounted between the axles of the truck and the car floor. This car is at present in regular service. This company is also issuing Bulletin No. 4729, illustrating and describing the various designs of Mazda diffusers. The special advantages of these lamps are said to be the wide range of capacity, relatively low intrinsic brilliancy with excellent diffusion and economical distribution of light.

NOTES.

THE BETTENDORF AXLE CO.—This company has removed its offices from the Old Colony Bldg. to the McCormick Bldg., Chicago.

MCCORD & COMPANY.—The address of this company has been changed from old Colony Bldg., to People's Gas Building, Chicago.

WAUGH DRAFT GEAR CO.—This company announces the removal of its offices from 1525 Monadnock Block to Suite 809 People's Gas Building, Chicago.

CHICAGO RAILWAY EQUIPMENT CO.—The sales offices of the above company have been removed from the Fisher Bldg. to the McCormick Bldg., Chicago.

STANDARD COUPLER CO.—This company has removed its Chicago offices from the Fisher Building to 1005 People's Gas Building, corner of Michigan Ave. and Adams St.

WISCONSIN ENGINE COMPANY.—Benjamin K. Hough has been appointed Boston sales manager, representing the company in the New England States, with offices in the Oliver Building, Boston, Mass.

FIRTH-STERLING STEEL COMPANY.—It is announced by E. S. Jackman & Co., general agents for the above company at 710 Lake St., Chicago, that E. O. Reynolds and Joseph Smith will travel exclusively south and west of Denver and El Paso.

THE NORTH-WESTERN METAL MANUFACTURING COMPANY.—Alfred Munch, formerly secretary of this company, has been elected vice-president to succeed W. C. Schroder. R. E. Cook has been elected secretary and treasurer, with office at Minneapolis.

BURTON W. MUDGE & CO.—Herbert Green, who was vice-president of the Grip Nut Company until May 1, has been elected vice-president of the above company, with office at Chicago. Mr. Green will devote his time to the mechanical features of the devices of this company.

J. ROGERS FLANNERY & CO.—George E. Howard has been appointed eastern representative of the above company instead of the Flannery Bolt Company, as announced in the May issue. This company is the general sales agent for the Tate flexible staybolt manufactured by the Flannery Bolt Co., of Pittsburgh.

P. & F. CORBIN CO.—J. B. Comstock, for six years with the Westinghouse Electric & Manufacturing Company at its East Pittsburg Works, and for four years manager of its Publication Department, severed his connections with that company in April to accept a similar position with the above company, of New Britain, Conn. Prior to Mr. Comstock's connection with the Westinghouse Company, he filled the same position with this company that he has recently been recalled to assume.

WESTINGHOUSE, CHURCH, KERR & CO.—Walter C. Kerr, president of the above company, died on May 8 at Rochester, Minn., to which place he had gone to undergo an operation for cancer. Mr. Kerr was born at St. Peter, Minn., on November 8, 1858. He was educated in the public schools of that town and later went to Cornell University, where he was graduated in mechanical engineering in 1879. In 1883 he became allied with the Westinghouse interests. His forceful personality and gift of organization was responsible for the development of Westinghouse, Church, Kerr & Co. from its small beginning to its present place in the engineering operations of the world.

FRONT END TESTS *

RESULTS OF A SERIES OF TESTS ON THE LOCOMOTIVE TESTING PLANT AT ALTOONA TO DETERMINE THE BEST ARRANGEMENT OF FRONT ENDS FOR PENNSYLVANIA ATLANTIC TYPE LOCOMOTIVES, CLASSES E2a AND E3a.

Draft and Back Pressure.—In the tests made by the Master Mechanics' Committee† oil was used as fuel and by its use the admission of air to the fire-box could be completely controlled. With this method of oil firing the effectiveness of any arrangement could be derived from the draft indications; the draft in the smoke-box at any fixed back pressure being dependent only upon the smoke-box arrangement.

As the problem here was to devise an arrangement that would clear the smoke-box of cinders, the use of oil as a fuel could not be considered and with coal as a fuel it was found impossible to duplicate draft readings under apparently similar conditions of running.

By means of an indicator connected to the exhaust pipe a few inches below the nozzle the back pressure was observed, and by running the locomotive under gradually increasing loads a series of readings of the back pressure and the corresponding draft or vacuum in the smoke-box were obtained. These readings were plotted and a comparison of the results for light and heavy firing indicates very clearly that the draft is so closely dependent upon the conditions at the grate that it cannot be used as a basis of comparison for different front end arrangements when firing coal.

In estimating the comparative merits of the different devices tried it then became necessary to take account of a number of factors, as

> The quantity of water that could be evaporated as compared with the standard front end.
>
> The evaporation per pound of coal.
>
> The general steaming of the locomotive as shown by the boiler pressure during a test.

From tests made with the standard front end it was known that the boiler could be expected to give an equivalent evaporation of about 16 pounds of water per square foot of heating surface with a friable coal and 18 pounds with a gas coal. To obtain the lower evaporation a speed of 160 revolutions per minute and a cut-off of 27 per cent. was required with locomotive No. 5266 with fully open throttle, and for the higher evaporation of 18 pounds, 160 revolutions and 32 per cent. cut-off with full throttle.

If the results with the standard front end could be equalled with a self-cleaning device the object of the tests would be accomplished, as with the added advantage of a self-cleaning front which would permit the use of a friable coal the capacity of the locomotive would not be reduced.

The tests were made with both a friable and a screened gas coal. The former was used for the preliminary runs, as with it large quantities of cinders are drawn through the tubes and the self-cleaning feature could be better observed than with a coal making less cinders.

The final series of tests were made with the gas coal, as it is one of the regular passenger coals.

The same fireman fired for all of the tests on locomotive No. 5266, with one exception, which will be noted later.

THE TESTS.

THE EFFECT OF A MOVEMENT OF THE DIAPHRAGM EDGE WITH THE STANDARD FRONT END.

Before any changes were made in the standard front end (see Fig. 1) some trials were made to note the effect on the fire of a movement of the lower edge of the diaphragm plate. The normal position of this edge for locomotive No. 5266 is as shown, 21½ inches above the bottom of the smoke-box. The plate was lowered 5½ inches from this normal position, and after a short trial run it was raised 5¼ inches above the normal position and a trial made.

These changes in the position of the diaphragm plate produced no marked effect upon the burning of the fire. It burned evenly over the whole grate under each adjustment of the diaphragm, and the locomotive appeared to steam as freely with the plate in either the upper or the lower positions as it did under normal conditions.

The fact that the diaphragm is perforated may account for the lack of sensitiveness or marked effect upon the fire when the plate is given a new position.

PRELIMINARY TESTS.

The trials of front ends made by the Master Mechanics' Committee did not determine the arrangement of the diaphragm plate

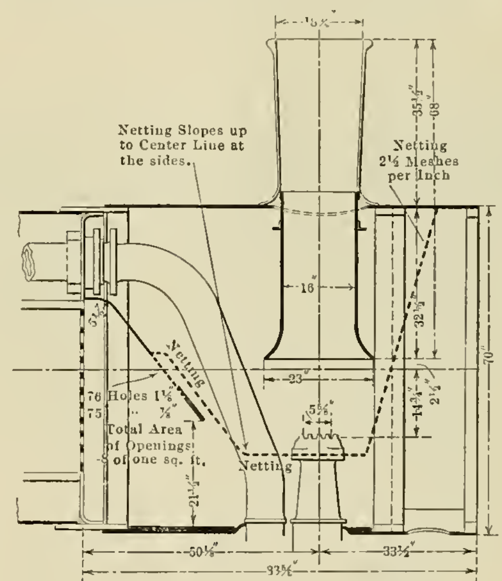


FIG. 1.

to make the smoke-box self-cleaning, and the first consideration in these tests was to investigate the shape of the diaphragm and its location in the smoke-box for this purpose.

A diaphragm of the general type recommended by the Committee as applied to this locomotive is shown on drawing Fig. 2. The whole diaphragm plate was without perforations, and, as first applied, extended beyond the center line of the nozzle a distance of 16¾ inches. At its end there was an angle and a plate 4¼ inches wide extending downward to a point 13¼ inches above the bottom of the smoke-box. The netting was omitted for these preliminary trials.

With the arrangement as described above a test was made (No. 900.25), using a friable coal and working the boiler at about the limit of its capacity to maintain a good pressure. The arrangement was found to be perfectly self-cleaning, there being no cinders at all left in the bottom of the smoke-box.

An inside stack according to the Master Mechanics' recommendations was then applied, and without other changes, a test (No. 900.26) was made at the same speed and cut-off as before.

* A brief summary of the conclusions of these tests appeared on page 227 of the June issue.
† See American Engineer, June, 1906, page 228.

The exhaust nozzle was then changed from 5⅝ inches diameter to 5⅞ inches diameter, but after but a few minutes of running with this large nozzle it was evident on account of the falling pressure that the nozzle was too large to give sufficient draft.

The nozzle was then reduced to 5¾ inches diameter and without other changes a test was made at a lower rate of evaporation than the earlier tests.

This arrangement was found to steam fairly well and to be perfectly self-cleaning.

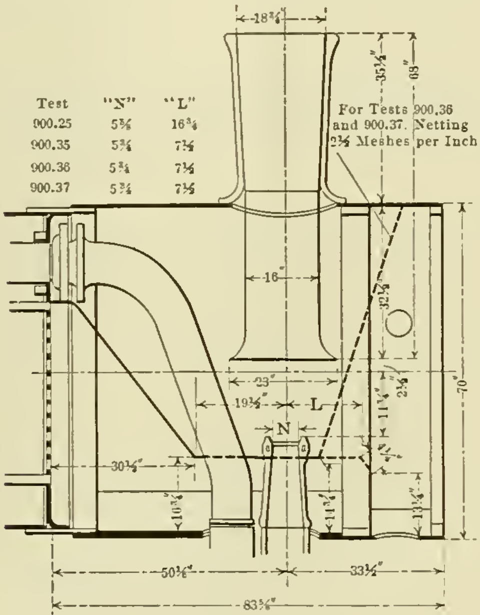


FIG. 2.

The smoke-box was then fitted with a stack that was exactly according to the Master Mechanics' recommendations (in the tests just mentioned the inside stack only had conformed to these recommendations). With this Master Mechanics' stack (Fig. 3) tests with 5¾-inch and 5⅞-inch exhaust nozzles were made, tests Nos. 900.29, 900.30 and 900.31. In these tests it was observed that while the cinders were all blown out of the front and there appeared to be a higher velocity of the gases through the restricted passage under the edge of the diaphragm than would be necessary for this purpose, or there was a large difference between the draft front and back of the diaphragm, indicating that too great a resistance to the passage of the gases was caused by the length of the diaphragm plate.

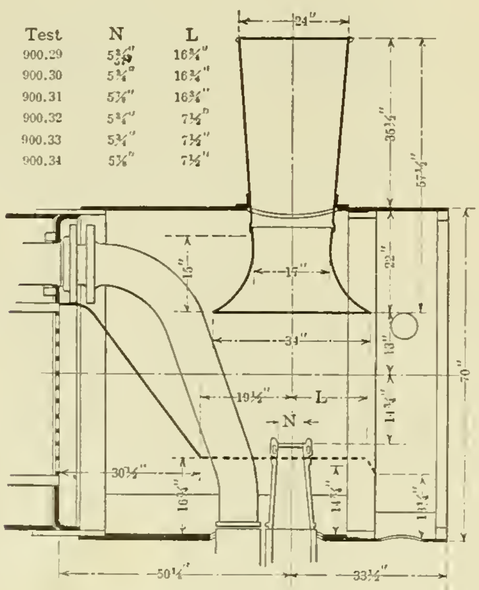


FIG. 3.

The plate was then cut off until it extended but 7½ inches in front of the exhaust nozzle center.

Tests Nos. 900.32, 900.33 and 900.34 were then run and in the table below the resulting draft readings are given:

TABLE NO. 1.
DRAFT IN FRONT END—FRIABLE COAL.

Test No.	R. P. M.	Cut-Off.	Throttle.	Duration of test, hours.	Draft in inches. Front of diaphragm.	Smoke-box, In of Water. Back of diaphragm.	Difference between F and B.	Cinders collected in smoke-box, lbs. per hour.
900.25	160	27	Full	1.5	4.9	3.2	1.7	0
900.26	"	"	"	1.0	4.8	3.3	1.5	0
900.30	"	"	"	1.0	5.3	3.7	1.6	0
900.31	"	"	"	1.5	4.8	3.4	1.4	0
900.32	"	"	"	1.0	5.2	4.3	.9	48
900.34	"	"	"	0.5	5.0	4.3	.8	..
917.*	"	"	"	3.0	7.7	6.2	1.5	492

* Standard front end.

While, in general, as has been explained, the draft indications cannot be depended upon as comparative, it appears from these figures that when the diaphragm plate was shortened just before

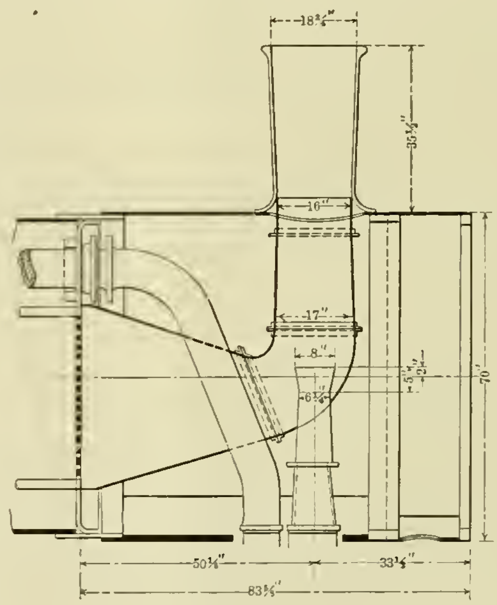


FIG. 4.

test No. 900.32, that there was a marked decrease in the difference between the draft front and back of the diaphragm, and that the effective draft, or the draft back of the diaphragm, was increased.

Test No. 917 was run with the same kind of coal as the others, but with the old form or standard front end.

In test No. 900.32 there were 48 pounds of cinders in the smoke-box, indicating that the plate was now as short as it could be made for self-cleaning.

The smoke-box arrangement was then made as shown in Fig. 2, the standard stack and inside stack being substituted for the Master Mechanics' form. A netting was put in with this arrangement.

Up to this time the netting had been omitted so as to simplify operations in making changes in the front end arrangement. It was assumed that the netting would have no effect upon the action of the front end, except to break up the large sparks, and this was confirmed later when the netting was applied.

After making two tests with this arrangement, the diaphragm plate was raised up in the smoke-box, the exhaust nozzle being lengthened to suit the new height of diaphragm. At the front edge the plate measured 20½ inches above the bottom of the smoke-box. With the diaphragm in this position the locomotive steamed well, but there were 255 pounds of cinders collected in the smoke-box per hour.

Without moving the main diaphragm plate, an inclined plate was fitted to its forward edge. This plate extended down to a point 15½ inches above the bottom of the smoke-box. The area of opening for the passsage of gases was then about the same as in the arrangement shown in Fig. 2, and it was expected that the results would be the same as with the whole diaphragm in the lower position, but from the test with this arrangement it was evident that the two arrangements, while giving the same area for the passage of gases, are by no means equivalent as in the last test the locomotive did not steam well, and there were 76 pounds of cinders collected in the smoke-box.

It would appear, then, that when changes are made in the height of diaphragm the whole plate should be raised and not the forward edge alone.

The plate without the movable defector presents, for the flow of gases, a passage free from obstructions or abrupt changes of form, and it is probable that this will account for the better results had with it than with the plate set high in the smoke-box, but having the movable edge plate.

Following still further the idea of making a smooth and direct

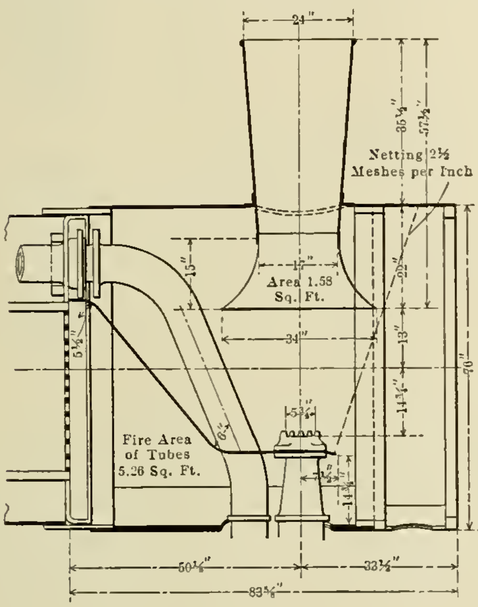


FIG. 5.

passage for the gases to the stack, the arrangement shown in Fig. 4 was applied. This consists of a conical pipe from the tube sheet carried forward and turning upward and connecting at its smaller end directly to the stack.

The exhaust nozzle for this arrangement was made with a flared tip, so that it would act as an expanding nozzle to convert the pressure energy of the steam into velocity without loss, in that way obtaining the most efficient exhaust jet.

A test was then made with this apparatus. It was verv effective in discharging cinders, but the nozzle was found to be too large to make the locomotive steam. The sparks discharged from the stack were at a red heat and to break up these and reduce their temperature a netting was put in the pipe back of the exhaust nozzle and the nozzle reduced in diameter. The netting could not be very large in area on account of the limited space, and it was found that the area of the opening through it was too small for practical purposes.

Nothing further was done with this arrangement, as it was not considered of value if a netting could not be used in it.

A diverging or flared tip nozzle was again tried with a diaphragm arranged as in Fig. 7, but with a Master Mechanics' inside stack. The smallest diameter of this nozzle was 5¾ inches, with a taper to the top of about one in six. The locomotive did not steam well with this nozzle, though the back pressure below the nozzle was reduced.

To make the locomotive steam it would have been necessary to further reduce the nozzle diameter, but as it was then as small as the straight nozzle, it was not reduced, and no further trials of it were made.

FINAL TESTS.

After the preliminary trials of the various devices that have been described, three of those which were of greatest promise were selected for further tests. These arrangements are shown in Figs. 5-6-7.

Figure 5 shows the front end recommended by the Master

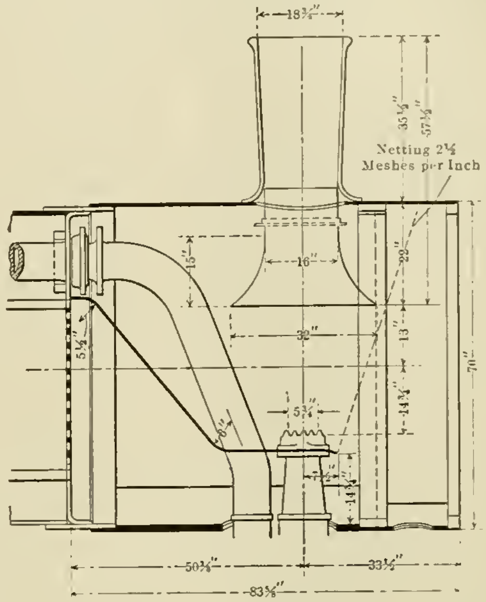


FIG. 6.

Mechanics' Association as applied to the "E2" or "E3" locomotive. It has a tapered stack with a wide mouthed inside stack. The diaphragm plate is without perforations and is carried down and forward to a point 7½ inches in front of the exhaust nozzle center. The edge of the plate ends at a point 14¾ inches above the bottom of the smoke-box and the area of the passage for the gases at this restricted point is three-fourths of the area of the tube opening or fire area.

The tests made with these three arrangements were each of two hours duration at 160 revolutions per minute, or about 38 miles per hour. Tests Nos. 900.41 to 900.44 were run at the same cut-off with full throttle. A gas coal was used for all.

The results of these tests are given in the data sheets on the following page.

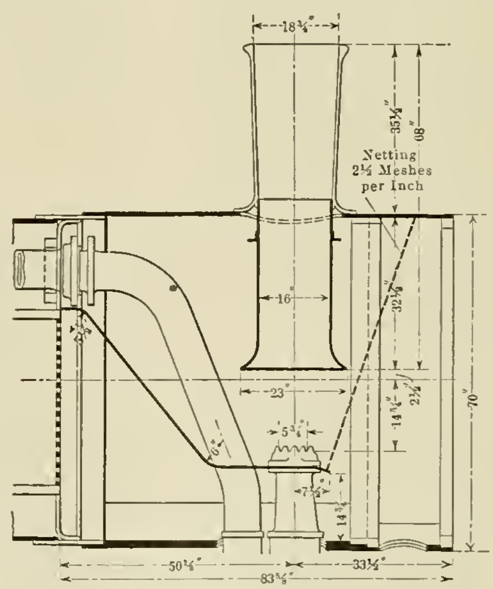


FIG. 7.

Good results were obtained with each of these arrangements. They were all perfectly self-cleaning except for a slight accumulation of cinders on the horizontal plate of the diaphragm.

RESULTS OF FINAL TESTS TO DETERMINE THE BEST DESIGN OF FRONT END ARRANGEMENT ON CLASS "E" LOCOMOTIVES

TEST NO.	900.41	900.42	900.43	900.44	900.45	900.46	900.47	1,001	1,002	1,003	1,004	1,005	1,006	1.007	1,908
Locomotive No.	5,266	5,266	5.266	5,266	5,266	5,266	5,266	2,984	2,984	2,984	2,984	2,984	2.984	2.984	2,984
Speed in M. P. H.	37.56	37.56	37.56	37.56	37.56	37.56	37.56	46.27	37.02	37.02	37.02	27.76	37.02	37.02	46.27
Throttle opening, full or partial	Full	Full	Full	Full	Full	Partial	Full	Full	Full	Full	Full	Full	Full	Full	Full
Back pressure in exhaust pipe, lbs.	2.15	1.90	2.03	1.71	3.53	.15	.78								
Average boiler pressure	200.8	203.4	204.6	202.3	199.5	203.8	195.8	199.6	201.9	200.5	199.9	202.7	200.4	200.4	202.7
Quality of steam in dome	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860	.9860
Draft, front of diaphragm	6.9	6.7	7.1	6.8	8.7	1 8	5.7	8.6	8.7	7.2	6.7	3.6	7.2	5.6	7.1
Draft, back of diaphragm	5.5	5.2	5.6	5.4	6.7	1.5	4.6	6.1	5.9	5.3	4.9	2.7	5.2	4.3	5.6
Draft in firebox	2.1	1.9	2.0	1.9	2.5	.6	1.9	2.3	2.2	1.8	1.9	1.2	2.2	1.8	2.2
Draft in ash pan	.3	.3	.3	.3	.4	.2	.3	.3	.3	.3	.4	.2	.4	.3	.4
Total lbs. of fuel fired	9,115	7,895	9,424	7,667	9,744	2,886	8,184	5,607	4,386	3,856	7,721	5,082	4,569	4,513	5,093
Dry fuel fired per hour, lbs.	4,489	3,888	4,641	3,776	4,799	1,421	4,030	5,523	4,321	4,577	3,803	2,503	4,501	4,409	5,016
Dry fuel fired per sq. ft. of G. A. per hr., lbs.	80.88	70.05	83.62	68.04	86.47	25.60	72.61	99.51	77.86	82.47	68.52	45.10	81.10	79.44	90.38
Cinders collected in smoke box, lbs. per hour	0	0	0	0	0	3	10	0	0	0	0	0	0	0	0
Sparks discharged from stack, lbs per hour	285	193	275	189	303	17	360	467	172	200	135	59	244	472	293
Analysis of smoke box gases, oxygen	7.1	6.9	10.1	9.6		10.0	4.3								
Analysis of smoke box gases, carbon monoxide	0	.1	Trace	.2		0	.3								
Analysis of smoke box gases, carbon dioxide	10.9	10.3	8.6	8.4		9.0	11 7								
Analysis of smoke box gases, nitrogen	82.1	83.1	81.3	81.9		81.0	83.7								
Lbs. of feed water delivered to boiler	62,330	59,411	62.063	60,873	69,351	28,411	57,763	34,088	33,330	26,735	60,000	41,645	32,375	25,970	33,695
Temperature of feed water	64.8	64.8	63.9	63.8	64.4	67.1	65.2	56.2	57.4	54.8	53.0	52.6	49.8	56.4	48.6
Lbs. steam delivered by boiler per hour	31,165	29,706	31,032	30,437	34,676	14,206	28,882	34,088	33,330	32,211	30,000	20,823	32,375	25,970	33,695
Dry steam per hour per sq. ft. H. S.	13.30	12.68	13.25	12.99	14.80	6.06	12.33	14.55	14.23	13.75	12.81	8.89	13.82	11.09	14.38
Dry steam per hour per lb. dry fuel	6.87	7.56	6.62	7.98	7.15	8.90	7.09	6.11	7.64	6.97	7.81	8.24	7.12	5.83	6.65
Equivalent evaporation per hour	37,282	35.552	37,177	36,458	41,497	16,970	34,525	41,111	40,142	38,870	36,255	25,183	39,237	31,297	40,891
Equivalent evaporation per hr. per sq. ft. H. S.	16.07	15.33	16.03	15.72	17.89	7.32	14.89	17.73	17.31	16.76	15.63	10.86	16.92	13.49	17.63
Equivalent evaporation per lb. dry fuel	8.31	9.14	8.01	9.66	8.65	11.94	8.57	7.44	9.29	8.49	9.53	10.06	8.72	7.10	8.15
Equivalent evaporation per lb. combustible	8.96	9.87	8.65	10.42	9.33	12.89	9.24	8.14	10.16	9.29	10.42	11.00	9.53	8.94	8.70
Boiler H. P.	1080.7	1030.5	1077.6	1056.8	1202.8	491.9	1000.7	1191.7	1163.6	1126.7	1050.9	730.0	1137.3	907.2	1185.3
Efficiency of boiler	55.80	61.38	53.79	64.87	58.09	80.18	57.55	51.00	63.69	58.20	65.33	68.97	59.78	57.54	53.85
Draw bar pull, lbs.	10,822	10,334	10,250	10,400	11,967	3,994	10,142	10,397	12.914	12,717	11,876	10,957	12,765	10,605	10,109
Draw bar H. P.	1084.1	1035.3	1026.8	1041.9	1198.9	400.1	1016.0	1283.0	1274.9	1255.4	1172.4	811.3	1260.2	1046.6	1247.5
Dry fuel per draw bar pull H. P. lbs.	4.14	3.76	4.52	3.62	4.00	3.55	3.97	4.30	3.39	3.65	3.24	3.09	3.57	4.21	4.02
Dry steam per draw bar pull H. P. lbs.	28.46	28.39	29.66	28.91	28.63	34.63	28.13	26.26	25.87	25.40	25.32	25.40	25.34	24.49	26.66
Thermal efficiency of locomotive, per cent	4.27	4.71	3.91	4.89	4.42	4.98	4.46	4.20	5.33	4.95	5.58	5.85	5.06	5.07	4.33

GENERAL DIMENSIONS OF THE LOCOMOTIVES ON WHICH THE TESTS WERE MADE.

Locomotive No.	5266	2984
Diameter of drivers	86	80
Driving wheel base, ft.	7.42	7.42
Total wheel base, ft.	30.85	30.85
Weight on truck	37,167	33,700
Weight on first drivers	53,334	56,700
Weight on second drivers	56,667	61,500
Weight, total, on drivers	110,001	118,200
Weight on trailers	37,000	31,200
Weight, total	184,167	183,100
Diameter of cylinders	20.5	22
Stroke	26	26

Locomotive No.	5266	2984
Valves, type	Double Ported Bal.	Richardson Bal.
Type of valve gear	Stephenson	Stephenson
Valve travel, in.	7	..
Lap of valve	1.5	..
Inside clearance	.16	..
Diameter of boiler, first ring	67	67
Tubes, No.	315	315
Tubes, diameter, in.	2	2
Tubes, length, in.	179.78	179.78
Total fire area, tubes, sq. ft.	5.26	5.26
Boiler pressure	205	205
Grate area	55.5	55.5
Heating surface fire side of tubes	2162.4	2162.4

Heating surface, firebox	156.86	156.86
Heating surface, total	2319.26	2319.26
Exhaust nozzle, diameter	5.625	5.75
Exhaust nozzle, area	24.85	25.97

ANALYSIS OF FUEL.

Test No.	900.41 to 900.47	1001 to 1008
Fixed carbon, %	56.52	56.11
Volatile combustible, %	34.74	33.99
Moisture, %	1.51	1.49
Ash, %	7.23	8.41
Sulphur, separate, %	1.67	1.53
B. T. U. per lb. dry fuel	14,382	14,088
B. T. U. per lb. combustible	15,529	15,403

There was some difficulty in keeping up the steam with the arrangement Fig. 5, test No. 900.41, but it will be noted that the boiler horsepower in this test was higher than for the others.

Test No. 900.44, with arrangement Fig. 7, shows a better evaporation per pound of coal than any of the others, and it was thought, all things considered, that this was the best arrangement.

Another test was then run with it to develop the maximum boiler capacity—test No. 900.45, at 160 revolutions and 32 per cent. nominal cut-off, and this test was run without difficulty. This is as late a cut-off as can be run with the standard front

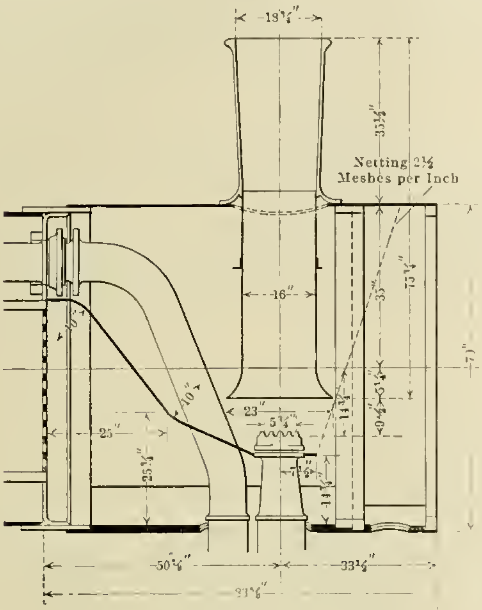


FIG. 8.

end at this speed, and as with arrangement (Fig. 7) the nozzle was ⅛ inch larger in diameter than was used with the standard arrangement, it is to be presumed that the boiler capacity is as great with this self-cleaning front as with the standard, with the added advantage of slightly decreased back pressure in the cylinders due to the large nozzle.

After this maximum capacity test a trial was made at a very low rate of working under partial throttle to note the effect of such conditions on the quantity of cinders collected in the smoke-box. This test, No. 900.46, at a speed of 160 revolutions, 27 per cent. cut-off and the steam throttled to one-half the boiler pressure, shows practically no cinders collected in the smoke-box.

TESTS WITH DIFFERENT FIREMEN.

To show that the results obtained with this self-cleaning front were not due to good firing alone, tests Nos. 900.42 and 900.43, with the arrangement shown in Fig. 6, were run under precisely the same conditions, with the exception that test No. 900.42 was fired by the regular testing plant fireman, while No. 900.43 was fired by an inexperienced man who had been firing but two months and had never fired this class of locomotive.

The results of these two tests show that the good steaming of the locomotive with this self-cleaning front can be obtained by the average fireman, but they also show that the inexperienced man may use as much as 750 pounds of coal per hour over the amount actually required.

SELF-CLEANING FRONT END OF "E3A" CLASS.

At this point, after tests which indicated that for locomotive No. 5266, "E2a" class, the self-cleaning front (Fig. 7) would give the best results, it was thought best to determine if this arrangement would give equally good results if applied to another boiler of the same class. Locomotive No. 5266, class "E2a," was, therefore, removed from the plant and put into road service equipped with arrangement (Fig. 7) and "E3a," locomotive No. 2984, fitted with the same arrangement, was placed on the plant.

Test No. 1001, with locomotive No. 2984, gave an evaporation that was practically the same as obtained with locomotive No. 5266, namely, 17.9 pounds equivalent evaporation per square foot of heating surface per hour. The locomotive steamed freely, maintaining a fairly uniform boiler pressure, and there were no cinders in the smoke-box except a small quantity on the horizontal plate of the diaphragm.

This test did not appear to be quite up to the limit of boiler capacity, and had it been possible the cut-off would have been extended, but it was found for this locomotive that the friction brakes were working up to their limit and no more power could be absorbed by them.

Another test, No. 1002, was then made with this arrangement at slightly lower power.

From these two tests, though they were not quite up to the maximum evaporation of the other locomotive, one of them was but five-tenths of a pound less per hour, and it is clear that this boiler will give the same results as the other with this front end.

Modifications of the diaphragm were then taken up to make it of such a shape that it would clear itself of the small quantity of cinders which had been collecting on it.

The plate was made sloping where in the earlier form it had been flat, just back of the exhaust nozzle. This modification of the form of the sheet did not have the desired effect, for in tests Nos. 1003 and 1004 with it, there was as large a quantity of cinders on the plate as before the change.

The inside stack was then lengthened as shown in Fig. 8, where the end of the stack is 7¼ inches above the tip of the nozzle. This adjustment had the desired effect, and in tests Nos. 1005 and 1006 the cinders were practically all cleared from the plate.

The inside stack was then raised, as in Fig. 9, to a point 12 inches above the nozzle, to find the highest position for this inside

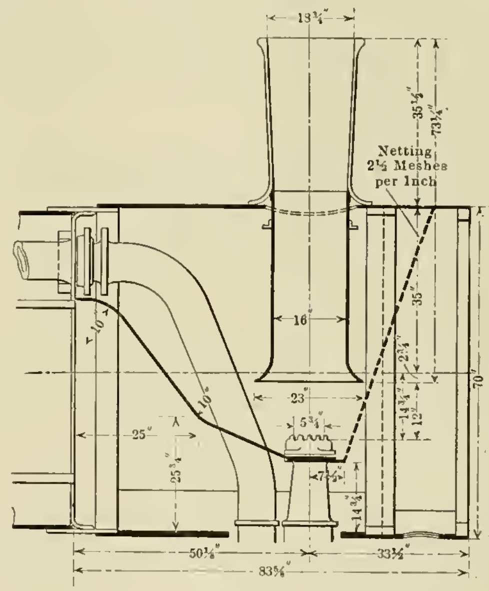


FIG. 9.

stack that would clear the plate of cinders. Six shovelfuls of dry cinders were put on the plate and the locomotive run at a speed of about 120 revolutions, and a short cut-off for about 15 minutes, when the cinders were all removed; next, six shovelfuls of wet cinders were put in, and these were also cleared from the plate.

A test, No. 1007, was then made, using a slack coal of very small size to note the effect of the self-cleaning feature. At the end of this test, with 472 pounds of sparks discharged from the stack, there were a few pounds of cinders on the plate and very little in the bottom of the smoke-box.

A test was then made, No. 1008, to observe if the capacity of the boiler had been reduced by the changes that had been made. This test gave an equivalent evaporation of 17.63 pounds per hour, or practically the same as in test No. 1001, with the arrangement last tried on locomotive No. 5266.

Locomotive No. 2984 was then removed from the plant and went into road service equipped with the device Fig. 9

In the table following some of the results of the tests of the final form of the self-cleaning front are shown in comparison with the standard front. The tests are in two groups, those with the friable coal being made at a shorter cut-off or lower evaporation than those with the gas coal.

TABLE NO. 2.
SELF-CLEANING FRONT COMPARED WITH STANDARD.

R. P. M.	Cut-off Ins.	Throttle.	Duration of test. Hours.	Speed in miles per hour.	Front end arrangement. Figure number.	Cinders collected in smoke-box. Pounds per hour.	Sparks discharged from stack. Pounds per hour.	Boiler pressure. Pounds per square inch.	Evaporation, Dry Steam per sq.ft. of heating surface. Lbs. per hour.	Equivalent evaporation per sq. foot of heating surface. Pounds per hour.	Equivalent pound of dry coal.	Coal fired.
160	27	Full	3	38	1	492	140	188.4	12.24	15.0	7.25	Friable
160	27	Full	1	38	2	10	529	199.9	12.25	14.76	7.28	"
160	27	Full	1	38	2	10	485	198.6	12.09	14.54	7.87	"
160	32	Full	2	38	1	326	341	201.2	15.04	18.24	7.01	Gas
160	32	Full	1	38	2	6	516	204.1	15.08	18.17	7.39	"
160	32	Full	2	38	7	0	303	199.5	14.80	17.89	8.65	"
200	25	Full	1	46	7	0	467	199.6	14.55	17.73	7.33	"
200	25	Full	1	46	9	0	293	202.7	14.38	17.63	8.15	"

CONCLUSIONS.

A front end arrangement has been developed for the "E" class which, while self-cleaning, maintains the boiler capacity or maximum evaporation fully equal to that with the standard front end arrangement.

With friable coals where large quantities of cinders are formed, the boiler capacity will be increased on long runs, on account of the smoke-box being kept clear of cinders which would obstruct the draft.

The front end arrangement recommended for the "E" class of locomotives is that shown in Fig. 9 to be used with an exhaust nozzle of 5¾ inches diameter.)

The outside and inside stacks as now used on this class of locomotive appear to give better results than can be obtained with the form recommended by the Master Mechanics' Committee, and it is thought advisable to retain them.

The best results were obtained when the passage for the gases under the diaphragm was smooth and free from abrupt changes of form.

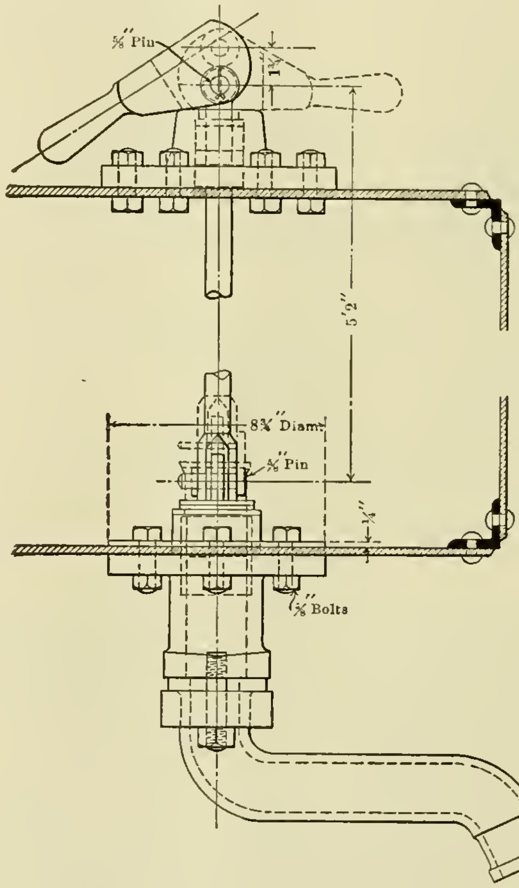
The inclined adjustable diaphragm plate, often used, was found to cause an obstruction to the flow of gases and is undesirable. In the experiments made the height of the whole horizontal plate of the diaphragm was varied and the final position recommended is suitable for any locomotive of this class and any means for adjustments is not considered necessary.

TOOLROOM MESSENGER SERVICE.—We have a system in Cleveland known as the material delivery gang system; it consists of a foreman at $60 a month, two assistants at 17 cents an hour, four helpers at 13½ cents an hour, and one messenger boy at 10 cents an hour. We do not allow a mechanic or helper to go to the storeroom. We have twelve miles of industrial track around our plant. A foreman must anticipate his wants 30 minutes in advance, with the exception of the roundhouse foreman, where there is a 10-minute delivery. A foreman may want 12 nuts delivered to engine 1250. At intervals through our plant we have little red boxes. He makes out his order and puts it in one of these. The messenger boy takes it up and the material is delivered to the engine, or wherever it is to be used. It costs us on an average of 2⅓ cents per order. I think if the general foremen would do this they would find a great saving. A good many of the laborers we have are foreigners, and when they went to the storeroom did not know what they wanted. In the morning we make every man go to the tool room and draw the necessary tools for the job he left the night before. He is not allowed to go to the tool room again before night. We have the same system in the machine shop. We have one boy who takes back all the tools that the mechanic is through with and sees to the drawing of new tools.—*J. A. Boyden at the General Foremen's Convention.*

A NEW TANK VALVE ARRANGEMENT.

Difficulty is sometimes experienced with the ordinary arrangement of tank valves, which are designed on the plug cock principle to open by the revolving of a handle, in that the valve would become partially clogged up and the fireman would lift the rod and valve in order to clear it with the usual result of unseating it.

To eliminate this difficulty and at the same time improve and simplify the construction at this point, the mechanical engineer's office of the Atlantic Coast Line has designed a valve which lifts by the action of a cam shaped handle. This valve has a beveled seat and provided with wings to permit a 1¾ in. lift. The valve stem guide at the top of the water leg and the valve



NEW TANK VALVE ON ATLANTIC COAST LINES.

stem itself are so constructed that a boss on the stem strikes the top of the guide at the maximum lift and prevents the possibility of the valve being lifted too far. The illustration shows the construction on a tank with the water leg and on a water bottom tank without side water legs, the arrangement includes a cast iron column passed up through the tool box compartment, being in other ways the same as that illustrated. With this arrangement the valve can be ground while in place and the splashing of water out around the valve rod is prevented.

PROGRESS OF ELECTRIC RAILWAYS.

On December 31, 1908, the length of the steam railroads of the United States was 232,045.9 miles. Accurate figures for electric railroads are not available, but on approximately the same data the length of the street and interurban railroads was in round figures, 35,000 miles. On a mileage basis the electric railroads shrink into insignificance and a comparison of gross earnings gives them a not much better showing. The gross receipts of the steam railroads in 1908 amounted to $2,590,400,124. The gross receipts of the electric railroads are less than one-sixth of that amount, being $440,000,000 annually. Practically all of that amount is passenger earnings which compares with passenger earnings of the steam railroads amounting to $575,246,516. On that basis the electric railways make a more favorable showing.

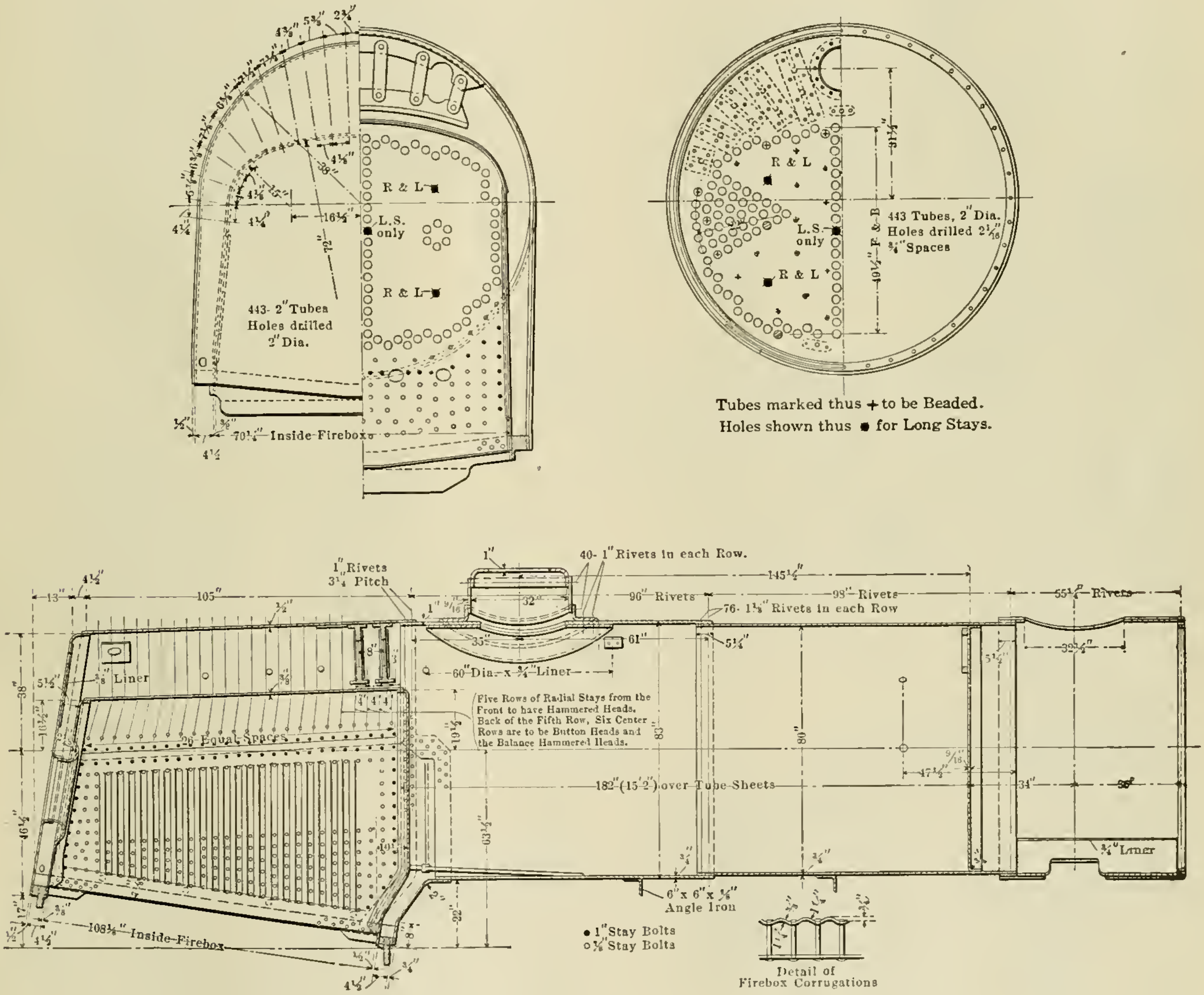
PACIFIC AND CONSOLIDATION TYPE LOCOMOTIVES.

Chicago & Northwestern Railway.

As one of the largest and most important American railway systems, the Chicago & Northwestern Railway is in a unique position in regard to its locomotive equipment. Up to recently this road has not owned any locomotives of either the Pacific or consolidation types, differing in this respect from practically every other large railroad in this country. The passenger traffic has been handled by powerful Atlantic type engines for high speed work and the ten-wheel locomotives for the heavier trains.* The freight traffic has been handled almost entirely by the ten-wheel type of locomotive.

Conditions of traffic have lately, however, made it advisable to employ larger train units and the American Locomotive Company has delivered an order of 25 Pacific and 40 consolidation locomotives to this company.

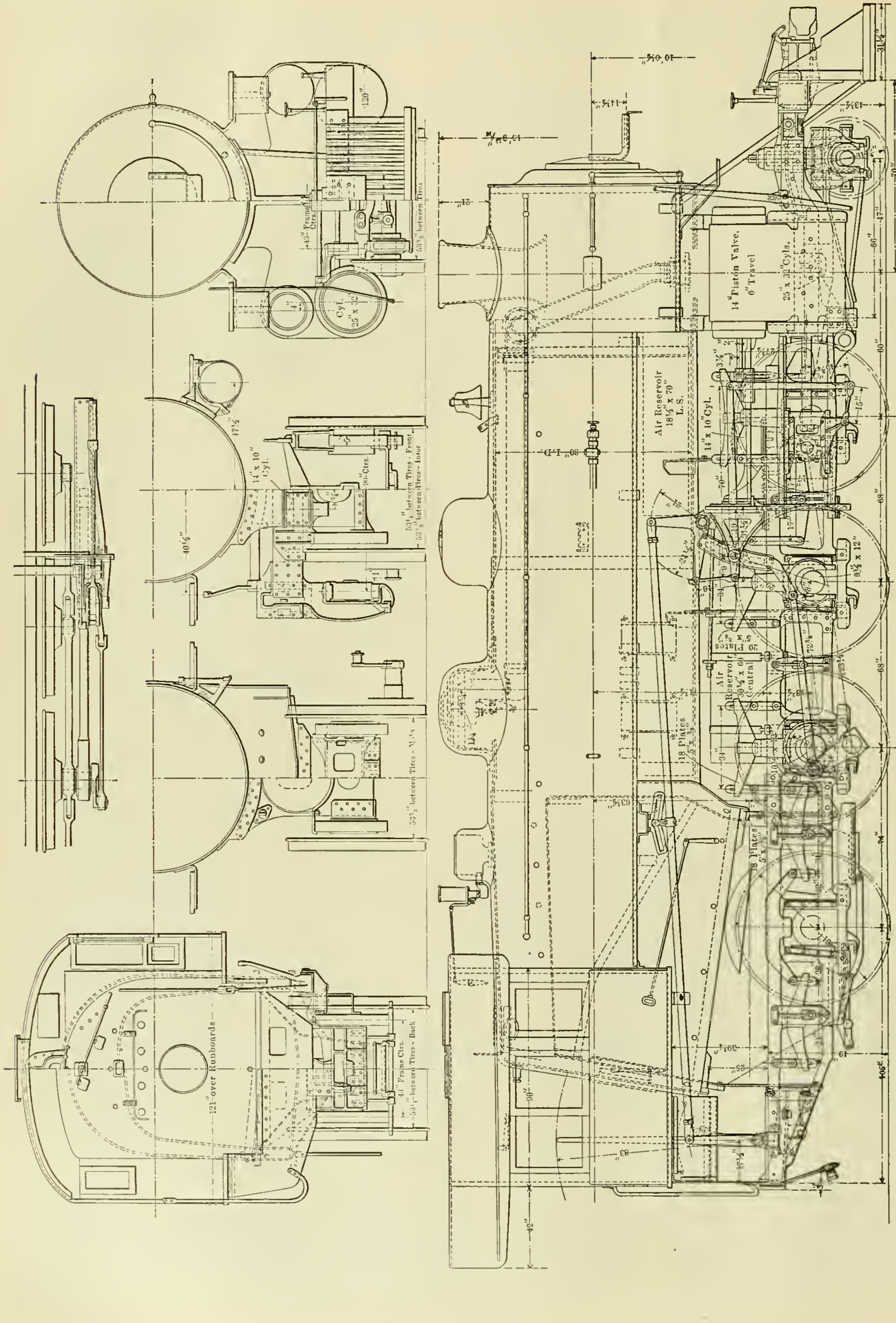
While, in view of the facts above stated, these locomotives are in a way experimental, there is practically nothing in the design of the passenger engines that is new or novel. They have 23x28 in. cylinders with 190 lbs. steam pressure, 14 in. piston valves and weigh 245,000 lbs., of which 151,000 is on drivers. The design is very similar to the locomotives of the same type which were built by the American Locomotive Co. for the Chicago & Alton Railway and were illustrated in the July, 1909, issue of this journal, page 268. The most noticeable difference is the employment of 75 in. drivers instead of 80 in. A careful examination of the general dimensions and ratios indicates that the vital importance of sufficient boiler capacity has been well recognized in both cases.



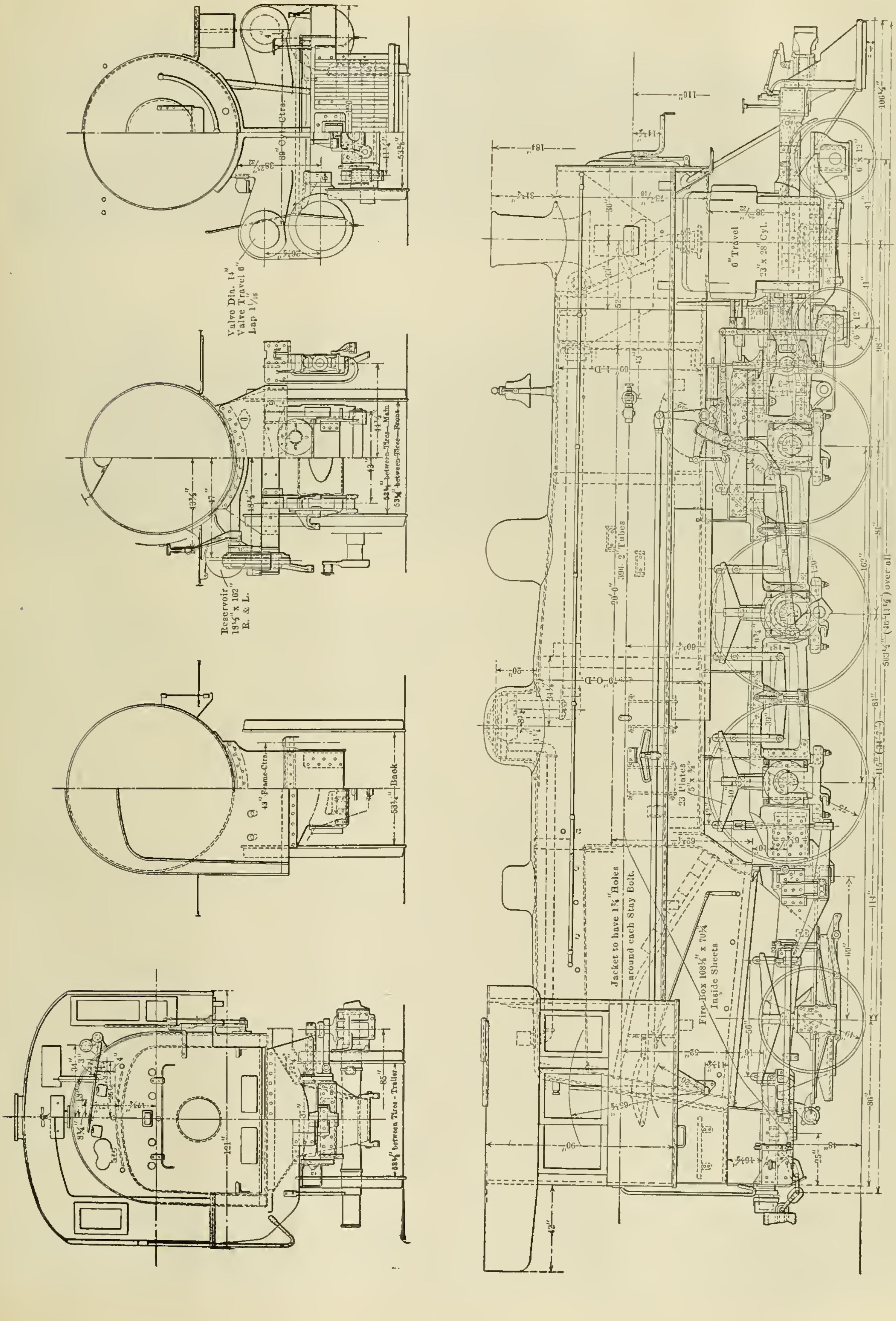
BOILER FOR CONSOLIDATION LOCOMOTIVE—CHICAGO & NORTHWESTERN RAILWAY.

A type of fire box that has been in service on this road for four or five years, with excellent results, has been applied to both types. This is of the corrugated side sheet type and was fully illustrated and described in the June, 1907, issue mentioned above. These side sheets are known by the name of Cour-Castle; the O'Connor large radius fire door flange is also used.

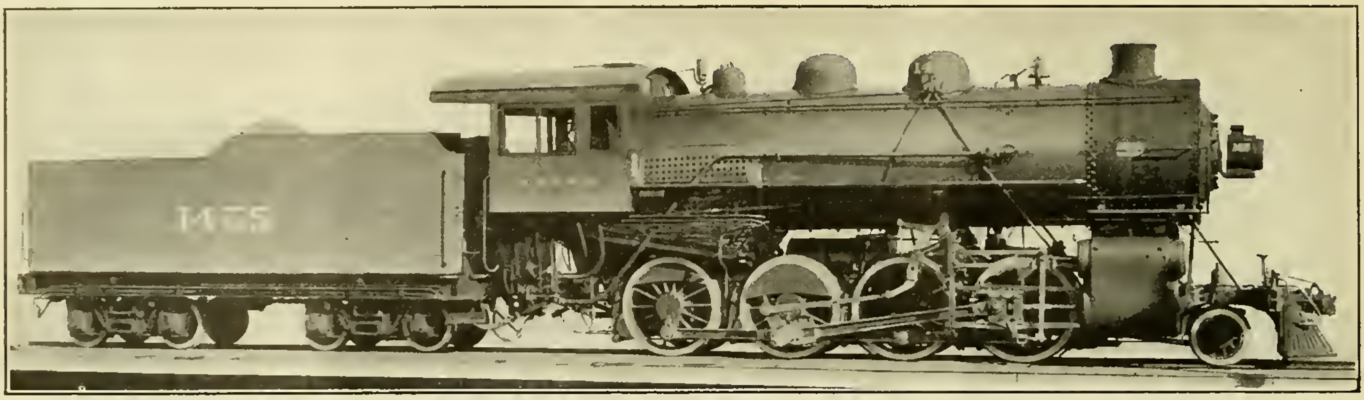
* See American Engineer, June, 1907, page 247.



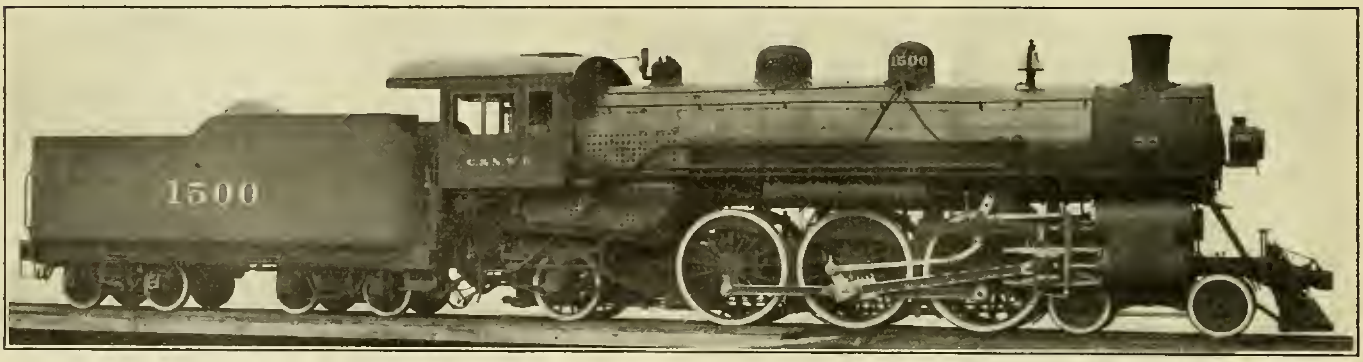
CONSOLIDATION (2-8-0) LOCOMOTIVE—CHICAGO & NORTHWESTERN RAILWAY.



PACIFIC TYPE (4-6-2) LOCOMOTIVE FOR THE CHICAGO & NORTHWESTERN RAILWAY.



CONSOLIDATION LOCOMOTIVE—CHICAGO & NORTHWESTERN RAILWAY.



PACIFIC TYPE LOCOMOTIVE—CHICAGO & NORTHWESTERN RAILWAY.

The cast steel frames consist of the main frame 5½ in. wide with a single front rail cast integral with it and a separate slab section 2½ in. wide at the rear for the trailing truck. The slab section is fitted into a recess at the back end of the rear frame, making a very strong and rigid splice.

Three-quarter inch bushings are fitted in the cylinders. The Walschaert valve gear follows the builders' latest pratice in the application to the Pacific type locomotive and is clearly shown in the illustrations. The frame bracing has been given very close study, the location and arrangement of the cross ties also being clearly shown in the illustration.

A trailing truck of the outside bearing radial type, the same as was applied to the Alton engine mentioned above, is used. This design was fully illustrated and described on page 269 of the July, 1909, issue of this journal. It eliminates the use of the outside supplementary frames, thereby simplifying the construction and effecting a considerable reduction in weight.

The consolidation locomotives have a total weight of 232,000 lbs., of which 88.3 per cent. is carried on the driving wheels.

One of the most interesting features of this design lies in the use of an unusually low boiler pressure with saturated steam. The pressure is but 170 lbs. and 25x32 in. cylinders are employed. These were very carefully and thoroughly lagged in order to reduce, as far as possible, cylinder condensation that would otherwise be excessive.

Fourteen inch piston valves are also used on these locomotives, being actuated by the Walschaert valve gear. Five inch cast steel frames with a single integral front rail are employed.

The illustrations show the general construction and also the details of the large boiler, of the straight top radial stayed type.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.		
Type	4-6-2	2-8-0
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Service	Pass.	Frgt.
Fuel	Bit. Coal	Bit. Coal
Tractive effort	31,900 lbs.	47,500 lbs.
Weight in working order	245,000 lbs.	232,000 lbs.
Weight on drivers	151,000 lbs.	205,000 lbs.
Weight of engine and tender in working order	399,100 lbs.	382,900 lbs.
Wheel base, driving	13 ft. 6 in.	17 ft. 6 in.
Wheel base, total	84 ft. 7 in.	26 ft. 6 in.
Wheel base, engine and tender	66 ft. 10½ in.	60 ft. 9½ in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.73	4.30
Total weight ÷ tractive effort	7.68	4.88
Tractive effort × diam. drivers ÷ heating surface	548.00	780.00
Total heating surface ÷ grate area	82.40	70.40
Firebox heating surface ÷ total heating surface, %	4.79	5.00
Weight on drivers ÷ total heating surface	34.80	63.90
Total weight ÷ total heating surface	56.20	62.30
Volume both cylinders, cu. ft	13.28	18.16
Total heating surface ÷ vol. cylinders	328.00	204.00
Grate area ÷ vol. cylinders	3.99	2.90
CYLINDERS.		
Kind	Simple	Simple
Diameter and stroke	23 x 28 in.	25 x 32 in.
VALVES.		
Kind	Piston	Piston
Diameter	14 in.	14 in.
Greatest travel	6 in.	6 in.
Outside lap	1 1/16 in.	1 in.
Inside clearance	3/16 in.	0 in.
Lead, constant	¼ in.	3/16 in.
WHEELS.		
Driving, diameter over tires	75 in.	61 in.
Driving, thickness of tires	3½ in.	3½ in.
Driving journals, main, diam. and length	10½ x 12 in.	10½ x 12 in.
Driving journals, others, diam. and length	9½ x 12 in.	9½ x 12 in.
Engine truck wheels, diameter	37¼ in.	31¼ in.
Engine truck, journals	6 x 12 in.	6 x 12 in.
Trailing truck wheels, diameter	49 in.	———
Trailing truck, journals	8 x 14 in.	———
BOILER.		
Style	E. W. T.	Str.
Working pressure	190 lbs.	170 lbs.
Outside diameter of first ring	70 5/16 in.	81½ in.
Firebox, length and width	108⅛ x 70¼ in.	108⅛ x 70¼ in.
Firebox plates, thickness	⅜ & ½ in.	⅜ & ½ in.
Firebox, water space	4½ in.	4½ in.
Tubes, number and outside diameter	396—2 in.	443—2 in.
Tubes, length	20 ft.	15 ft. 2 in.
Heating surface, tubes	4,130 sq. ft.	3,499 sq. ft.
Heating surface, firebox	236 sq. ft.	214 sq. ft.
Heating surface, total	4,366 sq. ft.	3,713 sq. ft.
Grate area	53 sq. ft.	52.7 sq. ft.
Smokestack, diameter	19 in.	20 in.
Smokestack, height above rail	184 in.	183 13/16 in.
Center of boiler above rail	116 in.	120½ in.
TENDER.		
Tank	"U"	"U"
Frame	13 in. Chan.	13 in. Chan.
Wheels, diameter	37¼ in.	34¼ in.
Journals, diameter and length	5½ x 10 in.	5½ x 10 in.
Water capacity	7,500 gals.	7,500 gals.
Coal capacity	13 tons	12 tons

FIRES ON THE PENNSYLVANIA.—The annual report of the insurance department of the Pennsylvania Railroad System shows that the company's own employees extinguished 321 fires during 1909. These fires occurrred on property valued at more than $9,000,000, yet the loss amounted to only about $20,000.

A GENERAL LOCOMOTIVE INSPECTION

AN ACCOUNT OF THE METHOD OF PROCEDURE, SOME OF THE RESULTS AND THE CONCLUSIONS FOLLOWING A DETAILED INDIVIDUAL INSPECTION OF OVER FIFTEEN HUNDRED LOCOMOTIVES OF ALL TYPES AND SIZES.

By R. H. Rogers.

IN THREE PARTS—PART 3—INFERENCES AND CONCLUSIONS.

From a broad viewpoint it must be reluctantly asserted that locomotives are seldom uniformly maintained, even on the several divisions of any particular railroad. This criticism need not apply to the boilers of these engines, because uniformity does certainly exist in that quarter, not only on the individual railroads, but between railroads as a whole, and largely because legislation in certain States dictates tests and repairs as a compulsory procedure. Such refinement, however, has not been reached, nor is it desirable or necessary in connection with running gear and machinery, so dependence must be placed by the motive power management on the supervision and vigilance of the various divisions to keep these in proper condition.

The tabulated summary of the inspection of twelve divisions of a railroad, presented in the preceding article,* strikingly illustrates the great latitude which exists, no matter how the general situation may be hedged about with standard practises and special instructions. It shows clearly that these latter are not generally efficacious, although it must be admitted that there are few logical reasons why they should not be so, and the influence of personality is found to intrude here just as forcibly as in the conduct of private business enterprises.

Standard practises, which are never adopted until criticised by every master mechanic interested, may be presumed to achieve the same results on each and every division of a railroad, waiving, of course, the slight effect of varying service requirements, but nevertheless these articles have made it plainly apparent that such is not the case, and to establish the why and wherefore of the latter it is necessary to confine direct to the division at fault.

In view of the fact that all divisions are intended to be governed by the same rules the differences exhibited between existing conditions may arise (1) from insufficient appropriation or shop resources, or lack of ability to handle what is provided; (2) weakness in the local organization, which leaves its impress in one or more predominating detrimental conditions; (3) the human factor of fallibility on the part of the master mechanic in failing to view these latter in their true importance; (4) lack of sympathy with all or a portion of the standard practises, designed, of course, for the general good.

In the consideration last month of the five items in locomotive maintenance which apparently give the most trouble to hold in even reasonable check, these were defined as practically uncontrollable, that is, from a roundhouse standpoint at least, therefore the article largely confined to suggestions for back shop remedies, which it is believed would go far toward improving the conditions mentioned, no matter where located.

A similar review, however, of the above outlined associated features must necessarily be approached with hesitancy, because in their consideration it is not so easy to be convincing as in the former presentation of self-evident mechanical truths. Still the writer believes that some comment on the causes which he assigned for differences in existing conditions may not lack interest, although it is realized that his views may be as easily attacked as approved.

THE MONTHLY APPROPRIATION.

This plan for financing a division is open to equal praise and censure. It is commendable in the abstract, as it implies the assurance that the head of the division will live up to its provisions, provided that the wish to keep his job is paramount, and thus discipline and economy are served through the same instrument. It is a mean proposition, nevertheless, and strikingly uncharitable as well, because it never reckons of varying conditions which any one month can exhibit over its predecessor. This statement must necessarily appear bold and questionable, but the writer well recalls three roads with which he has been associated where the monthly allotment actually remained at a fixed figure for no less than three years.

Let us consider what changes took place in motive power procedure and requirements on at least one of these three roads in that interval, and it will be readily appreciated that its master mechanics were placed at a disadvantage. These changes in requirements means, of course, betterments, and to meet these satisfactorily insures that more money must be spent. In the first of these three years an engine might be adequately put through general repairs for $1,100, but standardization and the application of new standards, which marked the ensuing two years, easily raised this total cost to $1,500. Still the appropriation remained the same, and as the standards *must* be embodied something had to be slighted in order to come "out on the month." The following citation may be of interest as illustrative of this point. It shows what was expected at the end of the third year for the same money, where not a single one of the items prevailed at the incipiency of the first year.

Driving axles were previously permitted to run below the limit, whereas the new dictation necessitated their renewal if worn ¼ in. below nominal size. Driving wheel centers with cracks, formerly banded, must now be renewed in the instance of general repairs. Loose driving box brasses now to be renewed, where shimming was formerly countenanced. The application of tire retaining screws or bolts—an absolute requirement in the instance of all passenger engines. Driving box flanges to be planed taper to relieve the shoe and wedge flanges. Piston heads when worn 1/16 in. below the diameter of the cylinder to be renewed when formerly 3/16 in. was the condemning limit. All engines as they go through the shop to have counterbalances weighed up, and if necessary corrected. Hopper ash pans to be applied, replacing flat pans, in accordance with federal laws.

These are some of the items on the road in question which went to increase the cost of classified repairs, without five cents more being allowed on the monthly appropriation, and are far from representing the entire scope of the additional outlay imposed. For instance, at that time there was in vogue a standard inspection system of safety appliances, necessitating that the gauge cocks and water glass cocks be removed from the boiler and cleaned on the occasion of each washout; the cylinder packing was also supposed to be examined at the same time, and the drawbar and drawbar pins removed and annealed. The muslin flags were replaced in this period by metal flags, which latter each shop was supposed to get out for its own engines, and the adjustment of wedges and keying up of rods, formerly undertaken by the engineers, devolved on the shop through the provisions in a new agreement secured by the engineers that they would not be called upon to do this work.

There is no doubt but that some of the above operations had been performed in several shops on the road in mind, but they

* See American Engineer, May, 1910, page 181, and June, 1910, page 215.

were not mandatory, being largely at the discretion of the gang foremen. The moment, however, that they became absolute requisites it was necessary to deputize men to perform them, and not one single boy can be added in classified repairs without increased cost.

These new requirements, of course, came gradually during the three years, and the master mechanics cheerfully assumed them without protest, or properly, without request for additional appropriation to meet them, whereas the writer is confident that had any one of these master mechanics summed up and presented the items which entered into increased costs of classified repairs, as has been done here, an increased appropriation would have been forthcoming.

The road to which reference is now being made worked its various divisions on the lump appropriation plan; that is, the apportionment of the appropriation was made by the master mechanic for his different departments, without interference so long as the lump sum was not exceeded. In consequence when the back shop costs increased from 10 to 30 per cent., from the causes given, this amount must necessarily be secured from other shops under that jurisdiction. As the back shop, machine shop and roundhouse are the principal integral elements in an ordinary division terminal the two latter must of course bear their proportion of this additional burden. Naturally the roundhouse, through the mere exercise of common sense, which dictates that it should be left alone, would be the last to feel the retrenchment, but finally it goes on eight hours, with all the attendant grief which the reduction of working time on running repairs always implies.

With all these things in mind it would certainly appear that on roads where many betterments are constantly being made to engines receiving thorough repairs that the lump appropriation plan should give way to the single allotment system, in which the total amount for the month is already apportioned by the superintendent of motive power before the master mechanic is credited with it. It is only fair that the master mechanic should receive an additional amount to cover the cost of betterments, but it is also fair to the management that it should be spent only in the department where the betterments are effected. No additional clerical work need be entailed through this procedure as accounts are now generally returned for each separate department under the lump appropriation plan.

The latter, with the intimation which is usually forthcoming that under no circumstances must it be exceeded, is in many cases so productive of anxiety and uneasiness that the master mechanic is interfered with taking the practical interest in his shops which he must feel to get the results. His time, which should properly be spent in devising ways and means, and in combating the obnoxious features which his division exhibits, is devoted to calculations as to whether he has come out "even on the day," or is "in a hole on the day." It is wrong to burden a position always associated with so much harassing detail with this additional worry over the possible expenditure of one hundred dollars more than his appropriation.

Monthly conditions are too variable to allow any fixed amount, and to make the same absolute. Sometimes so delicate is the balance with the money at hand that an insignificant wreck, necessitating eight or ten hours overtime for the wrecking crew, will disturb it to the extent that the shop is behind on the day, and the deficiency must be supplied from the next.

The writer believes that in the long run affairs in general are better served through a tacit understanding that an approximate sum will be spent each month. In any old established shop it is comparatively easy to hit on a suitable amount for a basis, and although the master mechanic understands that it is the desire of the management that this total be approximated every month, he knows also that it is flexible to a certain degree, and that harsh criticism will not follow a slightly increased expenditure provided that a sufficient reason be given. The writer while master mechanic for quite a long time on a prominent eastern railroad found this arrangement to work to a charm, and with a minimum of personal worry.

The amount usually expended in the principal shop under his jurisdiction, as nearly as can be recalled now, was $4,500 per week, and in three years there was little variation from this in week to week. When it was exceeded there was a good and sufficient reason, and the management of that road was sufficiently broad-gauged to honor the payroll increase without question. This was an enviable condition of affairs when contrasted with the tight policy prevailing on many other railroads in the form of a binding appropriation which does not reckon of the unusual or the unexpected when it is allowed, and may serve to partially, at least, account for the excellent condition of the rolling stock on the road which the writer has in mind.

This sub-division of the present article was inspired largely because that preceding somewhat unsparingly condemned the neglect or lagging conception of requirements, which countenances the presence on a division of excessive end play, unduly sharp flanges, poor shoes and wedges, etc., and it was thought consistent after this arraignment to comment on the other and more subtle factors which influence locomotive deterioration. Certainly the appropriation feature which has been dwelt upon herein is one of much prominence in this connection. If the appropriation is not adequate, and unfortunately in many cases it is not, this fact affords the opportunity to evade responsibility even for conditions on which the appropriation had little or no direct bearing.

It is not recommended by any means that this practically universal plan be dispensed with, but the writer believes that it should be modified and made more elastic in its provisions. Of course, in the instance of a struggling road, making both ends meet by the exercise of the most stringent economy, the situation had no doubt best be left alone, but the procedure as now evinced in many quarters is inconsistent with the earning capacity of great railroads, and much of it embodies a distinct menace to the proper up-keep of their locomotives.

SHOP ORGANIZATION.

In the conduct of this particular feature there is largely in evidence the desire, if not the actual practise, to maintain a standard organization for all shops under the jurisdiction. From the standpoint of comparative accounting nothing can be offered in objection to this procedure, so far as the accumulation of impressive statistics is concerned, but unfortunately a close analysis of the latter shows them to be in the main fallacious because equal conditions do not exist between divisions.

It was quite apparent to the writer while traveling over the A. B. C. railroad that the shop organization, or properly the roundhouse organization, which was unquestionably adequate as applied to the H division, was nevertheless an absurdity on the F division. Conditions between these two divisions were utterly dissimilar. One included a thirty stall passenger roundhouse as well as a thirty stall freight house, with the resources of a large back shop and all the accompanying detail to draw upon, whereas the other had nothing but a five stall roundhouse, with a machine shop annex and no back shop. Still this latter division was supposed to conform at least to the outline of what prevailed on its neighbor, and a cumbersome manipulation of work resulted inimical to successful locomotive maintenance.

The fundamental idea of the standard organization may be all right, but the detail application is impracticable. Some of the provisions of standard shop practises and standard organization descend into absurdities when the attempt is made to universally apply them. Furthermore the demands imposed by the faithful adherence to standard practises are not adequately provided for in the standard organization, except possibly in spots.

For instance, the standard practises might call for the removal and annealing of all draw bars and draw bar pins on the occasion of each boiler wash, or the removal of the front cylinder heads and examination of the cylinder packing at the same time. With the very large force necessary to keep business going on the H division both of these would be possible, but practically impossible on the F division, with a force limited to five machinists and one small blacksmith fire, the latter solely for emergency work.

The instructions, however, governing these things are issued to all master mechanics without exception, and although common sense would dictate to the master mechanic of the F division that their observance could hardly be expected to be as binding on him as on his fellows with greater resources, still he realizes that nothing in the advices he has suggests anything of the kind. To avoid censure he makes a bluff at compliance, and it is simply time thrown away which might a thousand times be better applied to the correction of something evident and not chimerical.

For some unexplained reason roundhouse organization is lamentably weak at best, irrespective of what road or section of the country may be under consideration, and the imposition through standards of impossibilities does not tend to materially improve the prevailing conditions mentioned in the preceding article. An unbiased analysis of conditions anywhere would reveal that under the most favorable auspices merely sufficient machinists and boilermakers are allowed to do the routine work, with scarcely any reckoning on emergencies.

The standard organization, as generally constituted, specializes these men, particularly the former. There is a cab man, who packs the cocks, removes and applies injectors and tests the steam gauges when required; a valve man who looks after the valve setting, and often that alone; a shoe and wedge man, charged with the maintenance of those parts on engines in service; a packing man, to care for the metallic valve stem and piston rod packing; a steam pipe and exhaust man, for whatever repairs may be required in that line, and a spring man who contends with the removal and application of all driving and engine truck springs. In addition to these specialists there may be one or two in reserve for all around work on running repairs.

No matter what may be advanced for this system the writer claims that it will never result in a well balanced roundhouse organization All of these men cannot be occupied simultaneously. Many minutes in each hour are wasted, if not hours in the day, while they are waiting for something to turn up in their particular line, and the attitude of the roundhouse foreman, in many instances which have attracted attention, implies that it would be a breach of ethics to give those who are idle for the time being something to do out of their line.

It is through this allotment of labor and the evils attending it that the fallacy of attempting standard practises in the roundhouse is best illustrated. For instance, suppose that five engines are on hand for a boiler wash, and which according to the instructions must have their cylinder packing examined. This work must devolve on the one or two machinists mentioned who are employed on general running repairs, because it is not in the particular line of the specialists. About the time they get the cylinder heads off there will some real work show up for them elsewhere, but the foreman has had it impressed upon him in various staff meetings that this packing must be examined, so nine times out of ten he lets the real work go until the "next time," which, needless to add, never comes.

The writer knows that during the time these heavy cylinder heads are laboriously handled and pistons pulled, in almost every instance, needlessly, many a set of guides could be closed, and many a knuckle pin or bushing renewed; work which really counts.

All such practises, of which this is merely mentioned as an illustration, are intended to anticipate trouble; to correct latent defects before they assume serious proportions, and are, of course, based on the English idea of a "shed day," say once a week, for each locomotive, in which it is intended to perform the requisite amount of work to keep it going until the next shed day, thus minimizing the actual running repairs. Unfortunately through absolutely different conditions this country cannot reach the refinement which the railroads of the United Kingdom have attained in handling the question of locomotive repairs, and any imitation without a complete reorganization, which of course being untenable, simply does more harm than good.

The thought which occurs in this connection is that the reason locomotives in general were so much better maintained some twenty years ago is because the master mechanics had more latitude. In those days it was largely the case of one man dominating his local situation, and now the situation and the requirements often dominate the man. There is nothing mysterious or unsolvable about the wear of a locomotive engine, and the writer is confident that men sufficiently skilled in their trade to be made master mechanics, if left with reasonable latitude, can be depended upon to adequately maintain it. If each master mechanic were allowed to organize his own shop forces he would simply do what needs to be done, and in a few words this is the whole story.

HUMAN FALLIBILITY IN SUPERVISION.

In this consideration the above sub-head is intended to refer to the judgment of the master mechanic, or his immediate responsible subordinate, concerning what defects can be countenanced and what should be remedied forthwith. A brief previous mention has been made of the very great latitude which exists in the exercise of this judgment, and it is graphically portrayed in the tabulated summaries of the detrimental features which in the writer's opinion prevailed on the various divisions of the A. B. C. railroad at the time of the inspection. It is clearly apparent that in many quarters an exaggerated care was taken of relatively minor ends while vital items were palpably slighted.

A preponderance of pounding crossheads is recalled in connection with a certain division, and with little if anything else to criticise. The writer attempted to point out in his reports from that locality that this condition had reached a point where broken frames might even be traced to it. In view of the fact that this job can be so easily taken care of in running repairs, the whole situation simply resolves into neglect of this particular part. It was present in the territory of a thoroughly competent and conscientious master mechanic, but he failed to attach any importance to the yawning guide bars, and probably his foremen knew that he did not. This is mentioned merely as an illustration of what the writer has termed human fallibility as a factor in locomotive deterioration.

Some of this fallibility is in reality the riding of a pet and long cherished hobby to which the following curious reminiscence will attest. On a certain division the inspector was amazed to note that from ¾ inch to 1¼ inch slack had been purposely left between the engine and tender of all engines, and particularly new 4-6-2 passenger power. It was gravely argued that it was impracticable to take up all the slack, especially on long wheel base engines; that with ½ inch slack the chafing casting on the engine set tight against the wedge on the tender when passing around the curves leading into the roundhouse. In addition to this the master mechanic asserted that experiments had convinced him that considerable less tire wear was present with the slack allowed than when it was entirely taken up.

Perhaps needless to add this latter conclusion was entirely erroneous. It arose, no doubt, from the conjecture that with the wedge tight in rounding curves the tendency of the train is to draw the back flanges hard against the rail, whereas just the contrary effect is produced. A consolidation engine curving to the right has Nos. 2 and 3 flanges, right side, in contact with the low rail, and if any cutting is going to be done it will be in connection with Nos. 1 and 4, left side, which are grinding on the high or outer rail. It will appear, therefore, that the tight connection between engine and tender is a positive advantage in drawing the engine toward the lower rail, and in a measure freeing the only flanges which can cut—those running against the high rail.

The object of the adjustable wedge between the engine and tender, as the writer understands it, is to maintain an even tension on the draw bar pins, and to minimize the strains and metal fatigue which naturally follow to both draw bar and pins through a recurrence of shocks. Innumerable failures of these parts can be recalled by the writer on many roads with which he has been connected and in which the investigation showed conclusively resulted from excessive slack.

It is really astonishing that such an argument should be presented, but it is only one of many similar fallacies. They are unfortunate when they crop out on any division of any railroad because divisions are independent units with the same shop and road force often working in that territory for generations; hence once inaugurated, they are liable to be perpetuated.

Another forcible illustration of mechanical error in judgment was in connection with the fit of driving boxes on a certain division. The writer noticed that they were always properly bored; that is, sufficiently high in the crown to permit a fit on the center line of the axle. This was eminently correct, had they stopped there, but the next singular procedure was to take the box to a slotter and remove about ⅛ inch of metal back from the center line of the fit, affecting in all about 1 inch of the fit at the latter's most vital point of contact with the journal.

This extraordinary operation was explained by the master mechanic in that it permitted the grease passing through the perforated plate of the cellar lubricator to come into contact with more area of journal, and that it had been a local practise in that shop since the former box packing had been supplanted by grease.

Through following this unfortunate practise these engines had been leaving that shop from general repairs at the rate of five or six per month for quite a long period, and perhaps needless to add, with a grave internal disturbing force in the shape of box pound from the very day they left the shop. It became quite easy to trace the result through its subsequent ramifications in pounding and loose rod bushings and the utter impossibility to maintain the knuckle pins in anything like an adequate condition. It simply illustrates how an unfortunate theory can be foisted on a shop and remain there.

It is quite common on any railroad to see a valve seat and the valve simply planed, boxed up in the steam chest and the engine sent on her way, and in the very next shop the valve will be put down to a scraped and spotted bearing. In the first shop the driving boxes will be spotted to a fit; in the second they will be bored large enough to go on the journal and the wheel raised without even looking at the fit. The master mechanic in No. 1 shop will raise his engines off the engine truck center casting once in a while and dope the casting, but such a procedure is considered unnecessary in No. 2 shop, in fact, unknown. No. 3 shop will impose any number of penalties on its workmen if motion work pins are applied without being thoroughly case-hardened, while No. 4 shop displays considerable laxity in this regard, often slipping them in direct from the lathe.

This variation in ideas naturally introduces the concluding consideration of this series—the value of standard shop practises in securing uniform conditions.

VALUATION OF STANDARD PRACTISES.

The valuation is, in fact, to be considered more than the value, the latter being, of course, admitted, otherwise the practises would not have been introduced. If these latter do not secure the results for which they were devised, they are not approached in the proper spirit by those charged with their administration. These are rather positive expressions, but the writer's experience leads him to no other conclusion. A rather uncharitable view has been taken in this article of standard shop organization and some standard roundhouse operations, because the attempt is made to apply them under conditions too variable, but standard shop practises is a different matter and the writer is wholly in accord with the plan.

The general scheme for introducing the practises is for the office of the superintendent of motive power to send to each master mechanic or person interested a copy of the idea to be returned with a criticism. Should these returns indicate more approval than disapproval, the practise is, as a rule, adopted for the system at large. It is very seldom that general approval is requisite to secure the introduction of a practise. This is where the hitch occurs in what should be an ideal procedure.

Two or three master mechanics will always remain who have indicated disapproval, with their reasons, and hence they are not in sympathy with it. When the practise becomes standard they will lend only half-hearted acquiescence at best. It is an unfortunate condition and goes far to defeat the intent of the standard practises, but quite frequently the management is more to blame than the few refractory master mechanics in allowing some absurd practises to get into circulation.

There is no matter in connection with railroading which need be more carefully approached than a judicious selection of standard practises and in limiting these to cover the essentially vital features of locomotive maintenance. It is entirely wrong to overburden the idea with too many practises, and they should be halted at a point this side of taking the entire initiative away from the master mechanic or the back shop supervision.

The writer believes that the essential features to be embodied in standard shop practises should be the removal of piston rods, driving axles, crank pins, driving box brasses, engine truck axles and tender truck axles when worn to a certain limit, the latter, of course, to appear on the practise card covering the part. Standard clearances to be established between driving box end play faces and wheel hubs. Slide valves to be removed when flanges become reduced to less than ⅝ inch thick. The bore of cylinders not to be allowed to exceed the nominal diameter more than ⅝ inch before bushing is applied. Valve chamber bushings to be renewed when inside diameter is ⅛ inch greater than nominal diameter. Wearing plates to be placed over frames wherever application is possible to protect frames from chafing of spring hangers.

It is quite easy to secure the co-operation of any master mechanic in adhering to the above because they indicate common sense truths in which little difference of opinion is possible, but as has been said before, care should be observed to avoid too much refinement. If the motive power management insists on and secures the fundamentals, it is a long way toward solving the problem of keeping up its locomotives, and can safely leave the elaboration to the various shops.

The writer has noticed shop practise cards on certain roads with which he could not agree, and they carried little appeal to the majority of the master mechanics. One, for instance: "Cylinders are to be rebored when out of round 1/16 inch or tapered 1/16 inch," and another, "All pistons of engines shall be renewed if 1/32 inch less than the diameter of cylinder." It may be that these cards were inspired by the idea to return the engine to as good shape as it was when new and to save fuel, but it is working things too fine, and such matters should be left to the discretion of the shops. The writer could not appreciate the consistency of seeking the ideal in that particular quarter with the side rods and motion work falling off the engine.

The proper and intelligent handling of standard practises to secure the results which will be forthcoming when so handled is to have a general shop inspector continuously on the road, and reporting direct to the superintendent of motive power, or highest mechanical officer. Provided that the proper man is secured, with the necessary combination of mechanical ability and tact, more can be done in two months to secure adherence to the standards than the superintendent of motive power's staff meetings in two years. When certain standards are found to be impracticable this man will soon know of it and cause them to be revised or abolished before much harm is done. This is because the master mechanics and others will criticise with much more freedom to him than to the highest official in the motive power department.

The special general inspection of the A. B. C. railroad which inspired these articles proved of great value. Faulty conditions automatically righted themselves in a most surprising manner when it is considered that the inspector was entirely without authority to order anything to be done. The moral effect of the inspection resulted in practically an instantaneous return to better things all along the line, and it may be after all that anticipation of this result was one of the prime factors to call it into being.

Steel Passenger Cars on the Pennsylvania.—The Pennsylvania Railroad System has in service or on order nearly 2,000 all-steel passenger cars and it is announced that all future additions to the passenger equipment will be of all-steel construction. The Pullman Company is constructing a sufficient number of steel sleeping and parlor cars to equip the entire Pennsylvania System.

NEW QUICK DUMPING ORE CAR.

Pressed Steel Car Company.

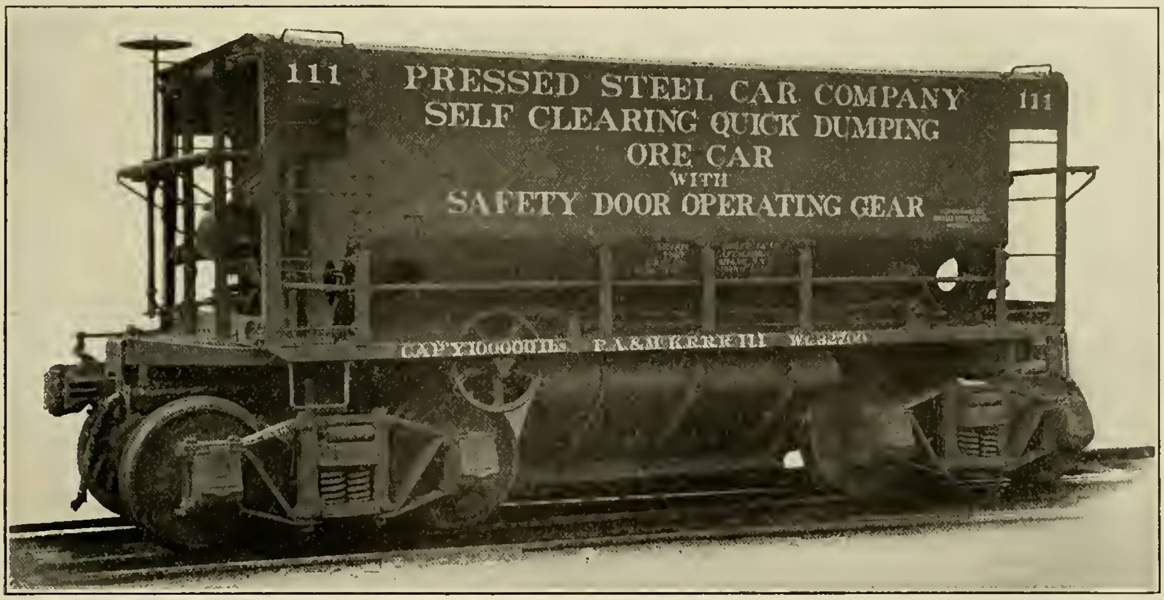
The transportation of ore from the mines to the docks at the Great Lakes and the unloading of the ore from the cars on the docks into the vessels for transportation over the lakes has always been an important part in the economical production of iron and steel, and the railroad companies engaged in this transportation have endeavored to own the best of cars and the best constructed docks in order to facilitate the unloading of the cars and the rapid loading of the vessel, all of which reduces the cost of transportation and the final cost of the ore at the furnaces.

The development of the cars to meet modern requirements on the lines of greater capacity and greater rapidity of unloading has, however, been considerably hampered by the permanent and expensive construction of the docks with pockets at regular short distances corresponding to the distances between the hatches on the vessels and in accordance with which the old equipment of wooden cars was built. This condition of circumstances cannot be changed without building new docks and changing the vessels, which is, of course, impracticable, as it would destroy interchangeability. This necessitates confining the general dimensions of new cars to the same length and to nearly the same width and height as the old equipment. Builders and designers of ore cars for this service were, therefore, not free agents in the construction of cars of the greatest efficiency, but were required to work in accordance with strict instructions, which, together with the comparatively limited knowledge available immediately following the introduction of steel cars, in regard to the strength and endurance of steel in car construction, naturally resulted in the building of cars which were not especially adapted to rapid unloading, or, in other words, were not self-clearing cars, requiring well-known features such as large unobstructed openings, steep slopes of hopper sheets and absence of sharp corners, similar to dumping cars and other apparatus used for different classes of ladings for many years.

Recently the question of a reduction in time and labor required to unload the cars has become of more importance, principally through labor difficulties, but also to effect a more rapid loading of vessels as well as less detention of the cars. With this in view, the railroad companies have permitted a number of variations from the old standard dimensions which makes a more ideal construction of the cars possible.

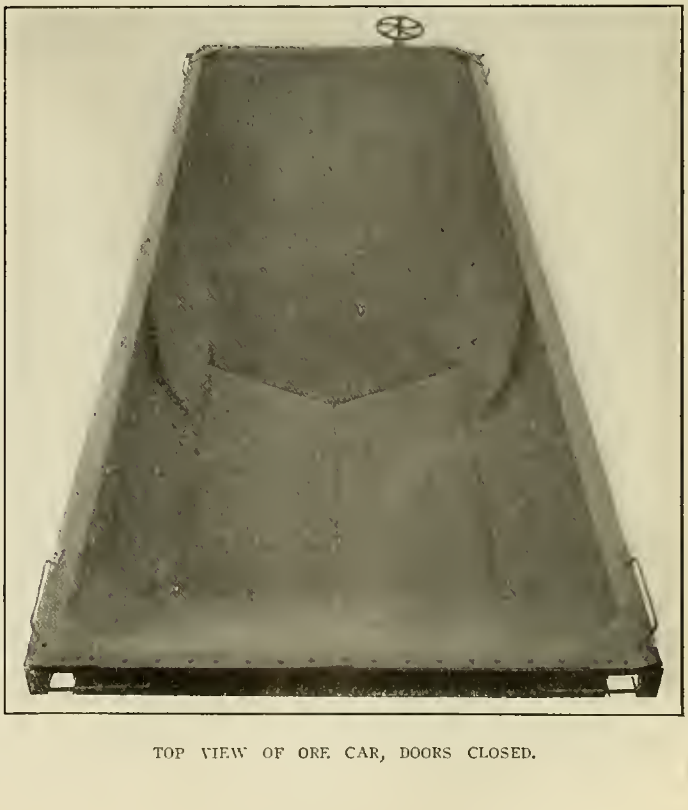
The Pressed Steel Car Company has just completed a sample car representing a lot of 300 cars which it is building at its Chicago plant, the Western Steel Car & Foundry Co., for the Duluth & Iron Range, and the Duluth, Missaba & Northern Railroads, in the design of which is shown what can be done when hampering limitations are removed. This car, of which several views are presented, is all steel construction, and has the following general dimensions:

Length over striking plates	22 ft. 1 in.
Length inside of body	18 ft. 1¾ in.
Width over side sheet	8 ft. 7 in.
Width inside of body	8 ft. 6½ in.
Height from rail to top of side	9 ft. 6 in.
Height from rail to center of draw heads	2 ft. 10½ in.
Length of door openings	6 ft. 7¾ in.
Cubic contents, level	686 cu. ft.
Cubic contents, ten inch average heap	802 cu. ft.
Weight of car and trucks, empty	32,700 lbs.
Rated capacity	100,000 lbs.
Maximum capacity	120,000 lbs.
Ratio of paying freight to total weight of car loaded	78.6 per cent.



VIEW OF QUICK DUMPING ORE CAR WITH POSITIVE DOOR OPERATING GEAR, SHOWING THE DOORS OPEN.

The car is of the single hopper center dumping type, and in order to make it self clearing and dispense with the necessity



TOP VIEW OF ORE CAR, DOORS CLOSED.

of poking the lading when unloading, the area of the bottom opening has been made very large, being about 50 sq. ft. and the slopes of the hopper sheets have been made 50° at the ends and 60° at the sides from the horizontal. These conditions were made possible without reducing materially the carrying capacity by increasing both the height and the width of the cars, reducing the wheel base of the trucks and spreading the trucks further apart from center to center. The door opening is closed by two doors hinged at the sides, which form part of the vertical sides, so that when opened, part of the sides, as well as the bottom, falls away from the load, thus making a large unobstructed opening, and reducing the chance of bridging to a minimum. The doors meet on the center line of the car and each are supported by two six inch channel bars, to which the door operating gear bars are attached.

One of the best features of this design is embodied in the door operating gear, which is arranged to be operated from either side of the car, and besides it is so arranged that when the doors are closed and the car is loaded, there is no strain on the winding gear proper; in other words, the supporting mechanism is self-locking and the load tends to keep the doors closed rather than to open them. This is accomplished by means of cranks which turn over a dead center into a position of rest. The doors are connected to the cranks by heavy rods with screw attachment for adjustment in place of chains; this prevents stretching and guarantees that the doors will stay tight, preventing leakage of ore in transit. Gears of this kind have given good service on coal cars, and have the further advantage of being positive so that when the doors are frozen and therefore cannot drop by gravity, they can be forced down by the connecting rods, which cannot be done with chain connections.

Another feature in connection with the door gear is a safety device absolutely positive in its action, and which will prevent the injury of the operator when opening the doors. To operate the doors the usual wrench is applied to the square end of the operating shaft; the crank arms referred to are revolved by means of block clutches having clearance of half a revolution, which permits the cranks to revolve for half a revolution, after having been brought over the dead center sufficiently to fully open the doors without moving the wrench in the operator's hands. After the doors have been opened the clutches are in proper position for closing the doors, there being no lost motion This arrangement is very simple, effective and readily understood. Every detail of the car has been worked out to secure the greatest economy in maintenance; the doors are stronger and more heavily braced than has ever been the practice in the past, which is essential to prevent distortion from steam shovel loading, under which usage it is particularly difficult to keep the doors tight and prevent leakage of ore.

In a recent test at the Clinton Furnaces at Pittsburgh the sample car was loaded with 100,300 pounds of wet ore and was unloaded by one man. The time consumed by the ore in leaving the car was eight seconds. Not a handful of the ore remained in the car, and no poking or hammering of the sides to loosen the ore was necessary, or resorted to, during the operation. The car was afterwards loaded with 68,000 pounds of steel punchings; the load being placed directly over the doors, and although this was a very severe test of the efficiency of the door gear, there was no sign of weakness or leakage.

Shop Card Index System.—"We have a system in our shop known as the card index system. We know each and every engine that is coming into the shop 30, 60 or 90 days in advance. Each foreman consults it and sees what is necessary and confers with the storekeeper so as to have his material on hand. Our shop was built in 1879 and is classed as a back number. Last month we took an engine in on April 11 and on the 19th we turned it out of the shop and it went into service on the 20th. It received a new set of driving boxes, shoes and wedges, and a firebox. We built an extra back end for the boiler. This we are doing for every class of engine we have on our system. This matter was lined up in one of our staff meetings with the storekeeper, and when the engine arrived on the pit each man had his part to look after. We had a flat car with a new firebox end on it, and it was placed behind the engine, one end of the car being empty. The other box was cut off on Tuesday morning, taken out to the turntable and pushed on the flat car which was turned, pushed back in and the other end put on the boiler. The jaws were faced on Monday and the shoes and wedges laid off on Tuesday. In order to get out of the way of the machinist, the blacksmith had to make two welds on the frames. We put him at that Monday evening. By planning and lining up these things we got wonderful results."—*F. C. Pickard at the General Foremen's Convention.*

TEST OF HOT WATER WASHOUT SYSTEM

The time consumed for the washing system at Macon, Ga., using the plant installed by the National Boiler Washing Co., Chicago, is as follows:

Washing Wide Firebox Consolidation, 1700 *Class,* 22 *x* 30 *in.*

Coupling blow-off hose	3 min.
Blowing off boiler, 50 lbs. steam, 2 gages water	40 "
Removing 22 mud plugs	15 "
Washing boiler	20 "
Putting in mud plugs	7 "
Filling boiler, 1 gage water	14 "
Getting 50 lbs. steam	30 "
Total, 2 hours and 9 minutes, or	129 min.

Washing Narrow Firebox Consolidation, 1030 *Class,* 21 *x* 32 *in.*

Coupling hose	3 min.
Blowing off boiler, 90 lbs. steam, 1 gage water	42 "
Removing 18 mud plugs	16 "
Washing boiler	31 "
Putting in plugs	12 "
Filling boiler	7 "
Getting 50 lbs. steam	34 "
Total, 2 hours and 25 minutes, or	145 min.

This class of boiler is the most difficult we have to wash.

Small 1500 *Class Engines,* 18 *x* 24 *in.*

Coupling hose	4 min.
Blowing off boiler	18 "
Removing plugs	11 "
Washing boiler	9 "
Putting in plugs	3 "
Filling boiler	5 "
Getting 50 lbs. steam	23 "
Total, 2 hours and 13 minutes, or	73 min.

Temperature—Washing, 150 deg.; filling, 200 deg.

System of Washing in All Cases.

1. Crown sheeet.
2. Flues at front end near checks.
3. Belly of boiler and bottom flues from front end of boiler toward firebox.
4. Back head, above and below fire door.
5. Sides.
6. Throat and back flue sheeets.
7. Arch pipes.

Washing water, 140 lbs. pressure; filling water, 180 lbs. pressure.

—*C. L. Dickert at the General Foremen's Convention.*

"A Study in Heat Transmission," by J. K. Clement and C. M. Garland, is issued as Bulletin No. 40 of the Engineering Experiment Station of the University of Illinois. This bulletin is for the technical reader and will be of interest to the student and physicist as well as the designer and operator of heating or cooling apparatus of any description. The results of the experiments apply directly to the problem of increased effectiveness of heating or cooling surfaces, which is a problem at the present moment engaging the attention of engineers. A large portion of the interest in the bulletin lies in the method of experimentation. The results show that the heat transmitted through the walls of a vessel in contact with water may be increased two or three times by increasing the velocity or rate of agitation of the water. Copies may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Lubrication Test at Purdue University.—By the addition of graphite to oil, there is a lower frictional resistance of the journal; the amount of oil required for a given service is reduced; a light or inferior quality of oil may be employed; water under favorable conditions may serve as a sufficient lubricant; a small amount of graphite only is required, as too much unduly thickens the oil and increases its internal friction due to vicosity. The benefits derived from the graphite persist long after its application has ceased.

MALLET ARTICULATED LOCOMOTIVE 2-8-8-2 TYPE.

NORFOLK & WESTERN RY.

The Baldwin Locomotive Works has recently completed five heavy Mallet locomotives with the 2-8-8-2 wheel arrangement for the Norfolk & Western Ry. These engines are designated by the railway company as Class Y-1, and each is practically equivalent in capacity to two twelve-wheeled locomotives of class M-1. The latter engines are the standard on this road for heavy freight service, and weigh in working order 204,000 pounds.

The new engines will operate over grades of 2 per cent. combined with uncompensated curves of 8 degrees. The sharpest curves on the main line are of 12 degrees. The track is laid with 85 pound rails.

These engines are in many respects similar to Southern Pacific locomotives 4000 and 4001, which were built in the spring of 1909. They are lighter, however, and present various differences in details. The design has been worked out along lines adopted by the builders for heavy Mallet locomotives, while the details, where possible, accord with existing Norfolk & Western practice.

The boiler is of the straight topped, separable type, with a feed-water heater in the front section. The fire-box has a sloping back head, and the crown is stayed by radial bolts; while 472 flexible bolts are placed in the outside rows in the sides, back and throat. The barrel of the main boiler is composed of three rings, with sextuple riveted butt seams on the top center line. The seams are welded at the ends. The dome is on the forward ring, and the seam is strengthened by a large diamond shaped welt strip placed inside.

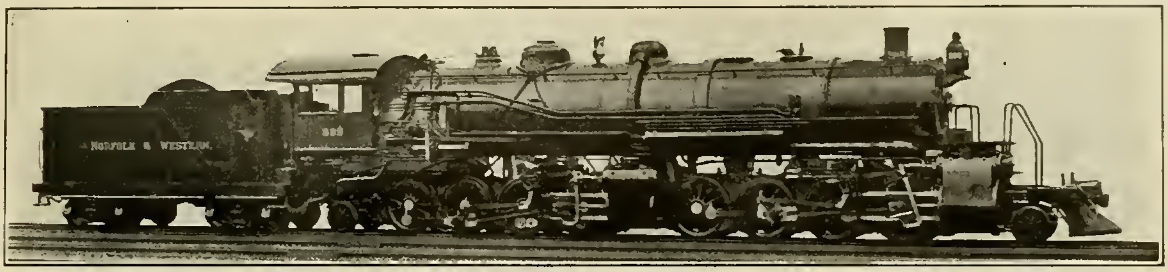
The water heater is traversed by 450 tubes, which are distributed over the entire cross section. Both injectors are placed on the right hand side in front of the cab, and they force water into the heater through a single check valve also placed on the right hand side. The heater is surmounted by a manhole, and the feed is discharged through a suitable fitting which is tapped into the manhole cover. The heated water enters the boiler proper through a single check valve, placed on the left side immediately back of the front tube sheet.

The arrangement of the steam piping is similar to that used on the Southern Pacific locomotives previously referred to. The high pressure exhaust is conveyed forward, through horizontal pipes, to the smoke-box, where it is passed through a Baldwin reheater. The spark arrester consists of a perforated plate, so located that all the products of combustion must pass through it before entering the stack.

The steam distribution is controlled throughout by 15 inch piston valves, set with a lead of ¼ inch. The four valves are duplicates of one another, those controlling the high pressure distribution being arranged for inside admission, while the low pressure valves have outside admission. The ports and bridges are modified to suit. The valves are of cast iron with L-shaped packing rings sprung in. Walschaert motion is used, and the high and low pressure gears are controlled simultaneously by the Baldwin power reverse. The front and back reverse shafts are connected by a single reach rod placed on the center line.

The arrangement of the articulated connection and the method of securing the cylinders to the frames, accord with the regular practice of the builders for engines of this size. The frames are of cast steel, 5 inches in width, and of most substantial construction. The pedestal binders are lugged to the pedestals and held in place by three 1¼ inch bolts on each side.

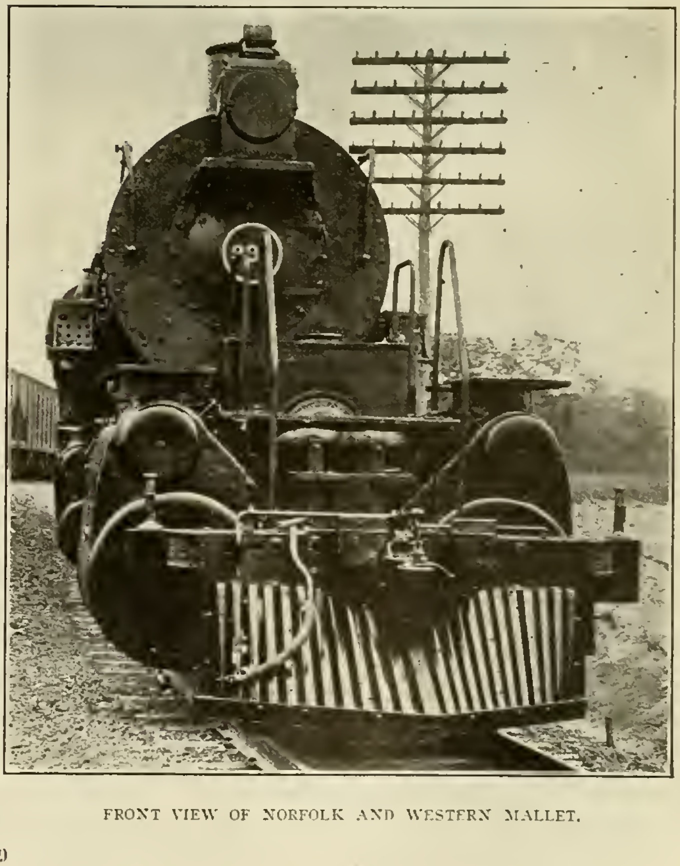
The equalization is continuous throughout each group of wheels, trucks included. The front truck is center bearing and the rear truck side bearing.



LOCOMOTIVE FOR SERVICE ON 2 PER CENT. GRADES WITH 8 DEGREE CURVES—NORFOLK AND WESTERN RY.

The waist bearers which support the forward boiler section are of the usual design, and are both under load. The fire-box is carried on sliding bearers at the front and back.

The tender frame is composed of 15 inch channels for the center sills and 12 inch channels for the side sills. The bumpers are of oak. The frame is strongly braced, and the frame bolsters are built up of ½ inch steel plates and 4 x 3 inch angles. The frame is braced transversely, at mid-length, by two 8-inch channels. The trucks are of the arch-bar type, with I-beam bolsters,



FRONT VIEW OF NORFOLK AND WESTERN MALLET.

triple elliptic springs and rolled steel wheels. The lower spring seats are mounted on rollers, thus providing the equivalent of a swing truck. The tank is of the water bottom type.

These locomotives are far larger than any previously built for the Norfolk & Western Railway, but for Mallet engines their size is not unprecedented. The principal features embodied in their construction have been fully tried out on locomotives previously built, and satisfactory results may therefore be anticipated.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	77,000 lbs.
Weight in working order, est	390,000 lbs.
Weight on drivers, est	360,000 lbs.
Weight on leading truck, est	15,000 lbs.
Weight on trailing truck, est	15,000 lbs.
Weight of engine and tender in working order, est	560,000 lbs.
Wheel base, driving	40 ft. 3 in.
Wheel base, total	55 ft. 6 in.
Wheel base, engine and tender	83 ft. 3 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.67
Total weight ÷ tractive effort	5.06
Tractive effort × diam. drivers ÷ heating surface	730.00
Total heating surface ÷ grate area	78.59
Tube heating surface ÷ firebox heating surface	20.50
Weight on drivers ÷ total heating surface	61.00
Total weight ÷ total heating surface	66.00
Volume both cylinders, cu. ft	23.05
Total heating surface ÷ vol. cylinders	256.00
Grate area ÷ vol. cylinders	3.26
CYLINDERS.	
Kind	Compound
Diameter	24½ and 39 in.
Stroke	30 in.
VALVES.	
Kind	Piston
Diameter	15 in.
Lead	¼ in.
WHEELS	
Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10 x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	30 in.
Trailing truck, journals	6 x 10 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	120⅓ x 90¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	F. 5½, S. & B. 5 in.
Tubes, number and outside diameter	350—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4,309 sq. ft.
Heating surface, firebox	210 sq. ft.
Heating surface, feedwater heater	1,389 sq. ft.
Heating surface, total	5,908 sq. ft.
Reheater heating surface	586 sq. ft.
Grate area	75.2 sq. ft.
TENDER.	
Water capacity	9,000 gals.
Coal capacity	14 tons

PAINT CAN STORAGE LOCKER

A locker for storing paint cans that are in daily use, as well as oils and other inflammable material, should be fireproof, capable of easy cleaning and sufficiently ventilated to prevent spontaneous combustion and so arranged that any can of oil or paint can be conveniently obtained without running any risk of tipping over other cans.

An arrangement which fills all of these conditions in an excellent manner has been installed at the Readville shops and is shown in the accompanying photograph. This consists of a platform slightly above the floor lever, covered with zinc plates and having a back about 30 in. high to which are hinged the covers that enclose the top and front of the locker. These covers are of sheet metal and are counterbalanced by weights on the cables passing over the pulleys seen projecting up from the back. They are provided with a small ventilator in the top and when closed make a locker that is sufficiently air tight to prevent rapid evaporation and drying of the paints, while still not being entirely unventilated. The locker here shown has three sections, and can, of course, be easily extended as required. In this are stored the cans of oils, paint cans that have been opened, brushes, etc.

VIEW SHOWING THE PAINT STORAGE LOCKER. THE COVERS ARE COUNTERBALANCED BY WEIGHTS AND HAVE VENTILATORS IN THE TOP. THE WHOLE LOCKER IS MADE OF SHEET STEEL

Electric Lighted Trains on the Burlington.—All the through passenger trains of the Burlington are now electric lighted throughout, from locomotive to observation platform. Seventy-two complete trains and practically all the reserve passenger equipment of the entire Burlington system have been equipped, including locomotives, baggage cars, mail cars, coaches, chair cars, dining cars, sleeping cars and observation cars. No such extensive and costly improvement of coach lighting has been attempted before.

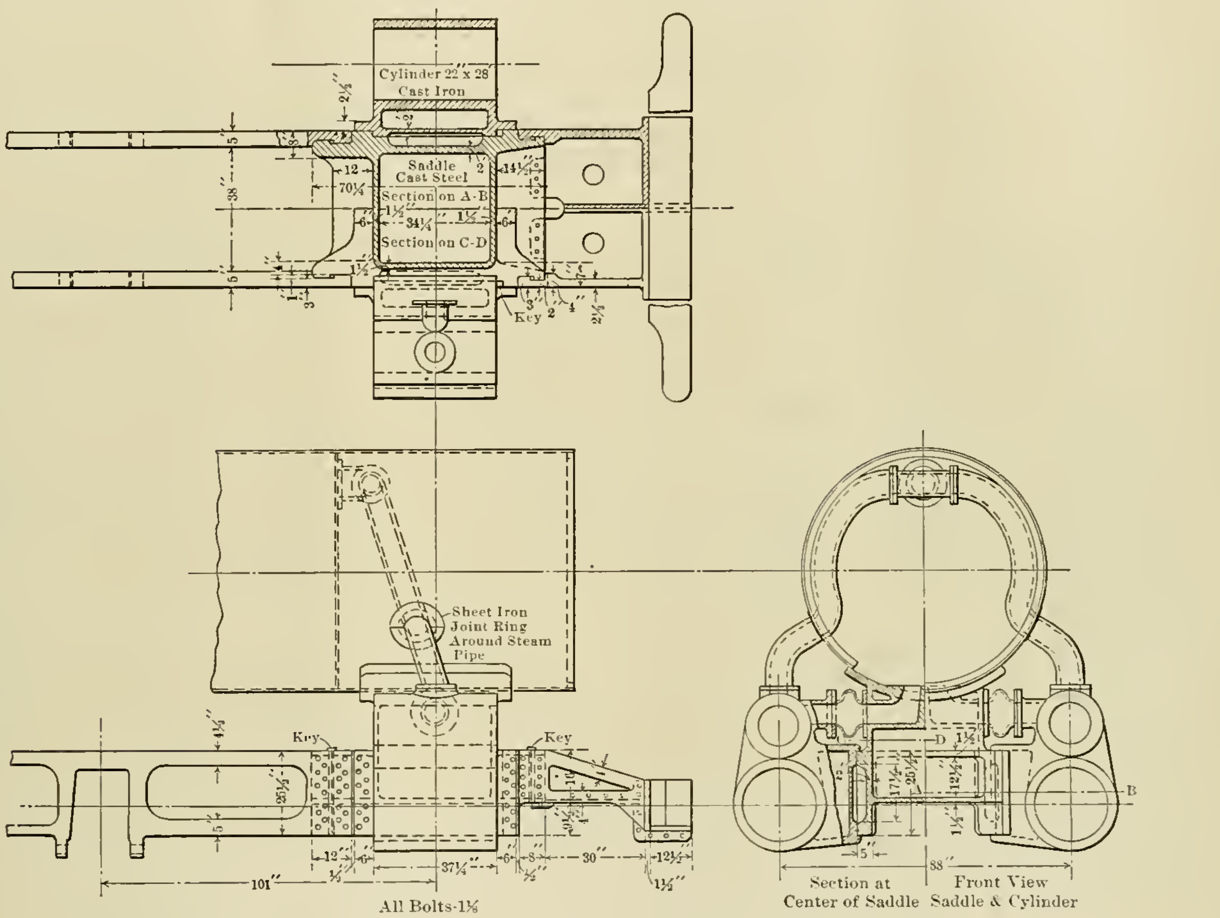
AN IMPROVED LOCOMOTIVE CYLINDER AND FRAME ARRANGEMENT.

A cylinder and frame construction which permits the terminating of the frames back of the cylinders and increases the strength and stiffness at this point, as well as simplifying the whole casting, has been patented by O. N. Terry and J. G. Crawford.

The construction provides a cast steel saddle that includes flanges front and rear to which the frames are securely fastened. The arrangement shown in the illustration is where the cylinders are cast separate from the saddle, although the same idea can be applied with the usual combined cylinder and half saddle. In the former case the saddle is of cast steel and contains the exhaust port only, this being a direct passage from the side of the saddle near the top directly to the exhaust pipe. The remainder of the casting is a shell with the necessary stiffening ribs and walls. The rear frame connections are arranged to cover the entire depth of the frame, the construction including a vertical key and horizontal bolts in the customary manner for rigid frame joints. A horizontal web at this point increases the stiffness. The same construction is provided at the front, the frames here probably being in the form of steel castings, including the deck plate. The cast iron cylinders are bolted and keyed to the saddle, the arrangement being for the steam pipes to enter the top of the valve chambers. In order to eliminate careful fitting a flexible joint is provided for the exhaust passage between the cylinder and saddle. This arrangement is clearly shown in the illustration. The steam pipes are continued outside of the front end just above the cylinder and enter the top in a manner somewhat similar to the usual construction on Mallet compounds at the high pressure cylinder.

With combined cylinders and half saddles the construction is very similar, with the exception that the exhaust passage is continued in the casting, the steam pipe connections being the same as those here illustrated. In this case it is recommended that the cylinder be of cast steel and provided with bushings for the pistons and valves.

The advantages of an arrangement of this kind in the matter of convenience of repairs, are readily apparent. The cylinders are easily removed without disturbing other parts in the vicinity; the front frames can be taken down quickly and the steam passages are much more direct and shorter and, in the case of the separable saddle, the cylinder castings are greatly simplified and cheapened.



FRAME AND CYLINDER CONNECTIONS FOR LOCOMOTIVE WITH SEPARATE SADDLE.

Scholarships for Grand Trunk Employees.—The Grand Trunk Railway has announced that the company will give free, three scholarships, each covering four years, in the faculty of applied science of McGill University, Montreal, Que., to apprentices and other employees of the company under 21 years of age and to minor sons of employees. These scholarships will be awarded under competitive examinations. Scholarships will be granted for one year and be renewed from year to year, to cover the four years, provided the holder makes satisfactory progress. The holders of these scholarships will be required to serve the road as student apprentices during vacation periods, and, at the option of the company, for two years after completing the college course.

High Speed Excursion Train.—On Saturday, May 21, the Michigan Central ran an excursion train of 12 cars, all well filled, from Windsor, Ont., to Falls View station, 224 miles, in 224 minutes; and, following this, another train of the same length made the same distance in seven minutes less; and both trains ran through without a stop. In making these fine runs the road had professional witnesses in large numbers. All of the passengers in both trains were members of the Brotherhood of Locomotive Engineers, who had been holding their biennial convention in Detroit.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

MALLET ARTICULATED COMPOUND LOCOMOTIVES

TYPE	2-8-8-2†	0-8-8-0	2-8-8-2	2-8-8-2	0-8-8-0	2-6-8-0	4-4-6-2†	2-6-6-2	2-6-6-2	2-6-6-2	2-6-6-2	0-6-6-0	2-6-6-0	2-8-8-2	0-6-6-0	2-6-6-2	2-6-6-2	0-6-6-0
NAME OF ROAD	A. T. & S. F.	D. & H.	N. P.	S. P.	Erie	G. N.	A. T. & S. F.	C. B. & Q.	G. N.	B. & A.	Mex. Cen.	B. & O.	V. R. R.	N. & W.	D. N. W. & P.	N. P.	G. N.	Can. Pac.
Road number or class	1,700	1,600	4,000	4,000	2,600	1,959	1,300	4,100	L-I	1,249	II	2,400	....	Y-1	200	4,000	....	1900
Builder	Bald.	Amer.	Bald.	Bald.	Amer.	Bald.	Bald.	Bald.	Bald.	Amer.	Bald.	Amer.	Amer.	Bald.	Amer.	Bald.	Bald.	Can. Pac
When built	1909	1910	1910	1909	1907	1909	1909	1909	1906	1910	1908	1904	1909	1910	1909	1909	1907	1909
Tractive effort, lbs.	108,300	105,000	94,640	94,640	94 800	82,000	62,850	70,500	71,600	66,600	71,600	70,000	70,800	77,000	74,130	57,760	57,760	57,400
Weight, total, lbs.	462,450	445,000	437,950	425,900	410 000	378,300	376,850	361,650	355,000	342,000	338,000	334,500	330,000	390,000	327,500	305,150	288,000	262,000
Weight on drivers, lbs.	412,350	445,000	403,800	394,150	410,000	359,600	268,400	304,500	316,000	296,500	300,000	334,500	312 000	360,000	327,500	262,350	250,000	262,000
Weight on trucks, lbs.	24,050	....	1[illegible],750	14,500	....	18,700	58,050	21,000	19,000	....	19,000	....	18,000	15 000	....	21,500	18,000	....
Weight on trailer, lbs.	26,050	....	15,400	17,250	....	....	50,400	36,150	20,000	....	19,000	....	....	15,000	....	21,300	20,000	....
Weight, tender loaded, lbs.	234 000	166,800	152,000	170,100	167,700	147,700	234,000	153,400	148,000	152,700	157,000	143,000	162,300	170,000	159,800	149,850	152,000	139,000
Wheel base, driving, front group	16′ 6″	14′ 9″	16′ 0″	15′ 0″	14′ 3″	10′	6′ 4″	11′ 6″	10′	10′	9′ 2″	10′	11′	15′ 6″	10′	11′ 2″	9′ 10″	10′ 4″
Wheel base, driving, rear group	16′ 6″	14′ 9″	16′ 0″	15′ 0″	14′ 3″	15′	12′ 8″	11′ 6″	10′	10′	9′ 2″	10′	11′	15′ 6″	10′	11′ 2″	9′ 10″	10′ 4″
Wheel base, total engine	59′ 10″	40′ 2″	56′ 7″	56′ 7″	39′ 2″	43′ 11″	51′ 11″	51′ 5″	44′ 10″	30′ 8¼″	44′ 2″	30′ 8″	39′ 11″	55′ 6″	30′ 8″	43′ 7″	43′ 7″	35′ 2″
Wheel base, engine and tender	98′ 0⅜″	75′ 7¼″	82′ 7¾″	83′ 6″	70′ 5½″	76′ 2½″	94′ 5½″	83′ 2½″	73′ 2¼″	74′ 8″	70′ 11″	64′ 7″	73′ 2⅛″	83′ 3″	64′ 4″	70′ 10½″	72′ 0¼″	60′ 7″
Diameter of drivers	63″	51″	57″	57″	51″	55″	73″	64″	55″	57″	55″	56″	54″	56″	55″	55″	55″	58″
Cylinders, high pressure, diameter	26″	26″	26″	26″	25″	23″	24″	23″	21½″	20½″	21½″	20″	22″	24½″	20½″	20″	20″	23¼″
Cylinders, low pressure, diameter	38″	41″	40″	40″	39″	35″	38″	35″	33″	33″	33″	32″	35″	39″	33″	31″	31″	34″
Cylinders, stroke	34″	28″	30″	30″	28″	32″	28″	32″	32″	32″	32″	32″	30″	30″	32″	30″	30″	26″
Steam pressure, lbs.	220	220	200	200	215	200	220	200	200	210	200	235	200	200	225	210	210	200
Boiler, type	Str.	Conical	Str.	Str.	Str.	Belp.	Str.	Str.	Belp.	Str.	Str.	Str.	E. W. T.	Str.	Str.	Str.	Belp.	W. T.
Boiler, smallest diameter	84″	90″	84″	84″	84″	84″	72″	78″	84″	83¾″	78″	84″	76″	80″	84″	74″	72″	57⅜″
Boiler, height center	....	120″	....	120″	120″	....	118″	114½″	120″	119½″	....	120″	116″	....	120″	....	116″	110⅝″
Heating surface, tubes, sq. ft.	4,766	6,276	4,941	4,941	4 971	3,038	3,275	2,708	5,473	5,291	4,311	5,380	4,842	4,309	5,035	3,816	3,708	2,605
Heating surface, firebox, sq. ft.	243	353	252	232	343	225	202	210	230	185	201	220	224	210	206	198	198	180
Heating surface, feed heater, sq. ft.	1,665	....	1,220	....	....	1,797	1 279	2,172	....	....	....	....	....	1 389	....	....	....	....
Heating surface, superheater, sq. ft.	544	....	....	655	....	480	323	464	....	....	....	....	....	....	....	....	....	420
Heating surface, reheater, sq. ft.	1,201	....	655	....	....	....	798	....	....	....	....	....	....	586	....	....	....	....
Heating surface, total,* sq. ft.	6 674	6,629	6,413	5,173	5,314	5,060	4,756	5 090	5,703	5 476	4,512	5,600	5,066	5,908	5,241	4,014	3,906	2,785
Grate area, sq. ft.	70 8	100	84	68.4	100	78	52.5	63	78	56.5	61	72.2	57	75.2	72.2	53.4	53.4	58
Firebox, length	129⅝″	126⅛″	126″	126″	126⅛″	117″	119⅝″	120″	117″	108″	123½″	108⅛″	114″	120⅛″	108″	116⅛″	116⅛″	120″
Firebox, width	7[illegible]⅞″	114″	96″	78¼″	114¼″	96″	63¼″	78¼″	96″	75¼″	71″	96¼″	72″	19¼″	96″	66¼″	66¼″	69⅞″
Fuel, kind	Oil	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Oil.	Lignite	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number	387	446	401	401	404	275	294	218	441	410	350	436	390	350	409	310	301	**
Tubes, diameter	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	2¼″	**
Tubes, length	21′	24′	21′	21′	21′	15′	19′	16′ 6″	21′	22′	21′	20′ 10″	21′	21′	21′	21′	21′	**
Tender, fuel capacity, tons	4000	14	13	2,850	16	13	4,000	13	13	12	3,500	16	14	14	12	13	13	12
Tender, water capacity, gallons	1,000	9,000	8,000	9,000	8,500	8,000	12,000	8,000	8,000	8,000	8,000	7,000	9,500	9,000	9,000	8,000	8,000	6,000
Weight on drivers ÷ tractive effort	3.78	4.23	4.26	4.18	4.32	4 38	4.27	4.33	4.40	4.45	4.20	4.75	4.41	4.67	4.40	4.56	4.34	4 57
Weight, total ÷ tractive effort	4.24	4.23	4.63	4.51	4.32	4.60	5.99	5.13	4.95	5.13	4.70	4.75	4.67	5.06	4.40	5.30	5.00	4 50
T. E. × diam. drivers ÷ total H. S.	1022.	807.00	840.00	1040.00	910.00	894.00	965.00	886.00	690.00	693.00	873.00	700.00	753.	730.00	780.00	785.00	813.00	1190.00
Total heating surface ÷ grate area	94.50	66.29	76.60	75.60	53.14	65.00	90.50	80.80	73.00	97.00	74.00	77.30	88.50	78.5	72.60	75.00	73.00	48.00
Firebox H. S. ÷ total H. S., %	3.65	5.31	3 90	4.50	6.46	4.45	4.25	4.13	4.13	3.40	4.45	3.92	4.42	3.55	3.90	4.94	5.05	6.46
Weight on drivers ÷ total heating surface	62 00	67.00	62.50	76.00	76.90	71.00	56.30	59.80	55.20	54.00	66.50	59.50	61.90	61.00	62.20	65.10	63.90	94.00
Weight, total ÷ total heating surface	69.40	67 00	68.00	82.50	76.90	75.00	79.20	71.00	62.00	62.00	74.50	59.50	65.10	66.00	62.20	76.00	73.80	94.00
Total H. S. ÷ superheating H. S.	12.40	....	....	7.90	....	10.50	14.70	10.97	....	....	....	....	....	....	....	....	....	6.63
Equivalent simple cylinder volume, cu. ft.	33.10	26.00	28.84	28.84	24.00	24.10	20.60	24.10	20.75	19.32	20.75	19.00	20.46	23.05	19.45	17.10	17.10	16.90
Total H. S. ÷ cylinder volume	205.00	254.00	223.00	180.00	222.00	210.00	232.00	212.00	275.00	283.00	217.00	295.00	247.00	256.00	270.00	235.00	229.00	165.00
Superheating H. S. ÷ cylinder volume	16.40	....	....	22.70	....	19.90	15.74	19.30	....	....	....	....	....	....	....	....	....	24.80
Grate area ÷ cylinder volume	2.14	3.85	2.91	2.38	4.70	3 24	2.54	2.64	3.75	2.92	2.93	3.85	2.79	3.26	3.70	3.12	3.14	3.44
Reference in THE AMERICAN ENGINEER	1909 p. 477	1910 p. 207	1910 p. 225	1909 p. 181	1907 p. 341	1910 Aug.	1909 p. 475	1910 p. 171	1906 p. 371	1910 p. 135	1908 p. 477	1904 p. 237, 262	1909 p. 261	1910 Aug.	1909 p. 61	1910 p. 225	1907 p. 213	1910 p. 81

* Includes boiler heating surface and feed water heating surface.
† Equipped with Jacobs superheater and feed heater.

** For number and size of tubes see AMERICAN ENGINEER, p. 89, 1910.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED IN ORDER OF TOTAL WEIGHTS

FREIGHT AND SWITCHING LOCOMOTIVES

TYPE	CONSOLIDATION (2-8-0)												MIKADO 2-8-2			SWITCHING 0-10-0	0-8-0	0-6-0
NAME OF ROAD	N. Y. S. & W.	D. & H.	P. R. R.	W. P. T.	L. S. & M. S.	C. & N. W.	C. & A.	C. G. W.	Wabash	A. T. & S. F.	C.S.N.O. & P.	C. N. O. & T. P.	N. P.	C. M. & St. P.	V. R. R.	L. S. & M. S.	V. R. R.	P. & L. E.
Road number or class	140	1,011	H. 8 B.	918	5,962	1,455	438	...	...	1,950	...	734	1,608	5202	421	M.	2	253
Builder	Bald.	Amer.	P. R. R.	Amer.	Amer.	Amer.	Amer.	Bald.	Bald.	Bald.	Bald.	Both	Amer.	Shops	Baldwin	Amer.	Amer.	Amer.
When built	1906	1906	1909	1909	1906	1910	1909	1909	1906	1908	1907	1907	1906	1909	1909	1905	1909	1906
Simple or compound	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Simple
Tractive effort, lbs.	54 100	49,690	42,661	46,900	45,677	47,500	39,800	46,630	42,600	44,000	43,300	44,100	46,630	46,630	50,350	55,300	45,200	44,100
Weight, total, lbs.	260,100	246,500	238,300	236,000	232,500	232,000	228,000	222,650	214,500	212,400	207,000	203,600	261,000	260,500	254,000	270,000	182,300	178,200
Weight on drivers, lbs.	232,700	217,500	211,000	207,000	207,000	205,000	203,500	198,850	189,600	183 200	182,000	182,000	205 000	201,000	207,450	270,000	182,300	178,200
Weight on trucks, lbs.	27,400	29,000	27,300	29,000	25,500	...	24,500	23,800	24,900	29,200	27,000	21,600	26,000	25,500	20,850	...	...	...
Weight on trailer, lbs.	...	...	...	...	...	...	...	...	...	...	...	...	30,000	34,000	25,700	...	...	...
Weight, tender loaded, lbs.	161,900	152,400	158,000	154,000	149,600	150,900	165,100	144,000	...	175,200	148,000	146,400	177,800	154,000	173,000	...	111,400	121,300
Wheel base, driving	17′ 0″	17′ 0″	17′ 0½″	15′ 9″	17′ 6″	17′ 6″	17′ 9½″	17′	15′ 9″	15′ 6″	16′ 0″	16′	16′ 6″	16′ 6″	15′ 6″	19′ 0″	14′	12′ 0″
Wheel base, engine	26′ 6″	25′11″	25″ 9½″	25′	26′ 5″	26′ 5″	26′ 9½″	25′ 8″	24′ 6″	24′ 6″	24′ 4″	24′ 3½″	34′ 9″	35′ 1″	33′	19′ 0″	14′	12′ 0″
Wheel base, engine and tender	60′10″	57′7½″	59″ 5⅝″	59′11″	60′ 9½″	60′ 9½″	64′ 1 11/16″	58′ 6″	57′ 10½″	58′ 5″	56′ 3″	56′ 7¼″	63′ 1″	65′ 7¼″	65′ 10¼″	54′ 5½″	49′ 6 11/16″	46′ 2¼″
Diameter of drivers	63″	57″	62″	58″	63″	61″	62″	63″	58″	57″	57″	56″	63″	63″	56″	52″	51″	50″
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter and stroke	28″ × 32″	23″ × 30″	24″ × 28″	25″ × 32″	23″ × 32″	25″ × 32″	22″ × 30″	24″ × 30″	22″ × 30″	24″ × 32″	22″ × 30″	22″ × 30″	24″ × 30″	24″ × 30″	24″ × 32″	24″ × 28″	22″ × 28″	21″ × 30″
Valve gear, type	Wals	Wals.	Wals.	Wals.	Wals.	Wals.	Pilloid	Wals.	Steph.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Steph.	Steph.
Steam pressure, lbs.	160	210	205	160	200	170	200	200	200	160	200	200	200	200	180	210	200	200
Boiler, type	Str.	Wooten	Belp.	E. W. T.	Rad. stay	Str.	Str.	Str.	W. T.	Str.	Str.	Str	E. W. T.	E.W.T.	Str.	W. T	Str.	Str.
Boiler, smallest diameter	84″	83¾″	76¾″	80″	81⅝″	81½″	80″	80″	77″	78¾″	78″	76 11/16″	75¾″	75¾″	78¾″	80 1/16″	74″	80″
Boiler, height center	120″	113″	117″	...	118¼″	120½″	...	...	...	114″	115½″	114⅞″	118″	118″	112″	115″	109″	108½″
Heating surface, tubes, sq. ft.	3,931	3,716	3,652	3,093	3492.18	3,499	3,175	3,514	3,053	2,773	2,939	3,051	3,192	3,332	4,277	4,422.6	2,763	2,906
Heating surface, firebox, sq. ft.	198	329.5	187	190	213.05	214	197	171	192	157	183	175	245 †	282†	189	197	177	206
Heating surface, total, sq. ft.	4,129	4045.5	3,839	3,283	3705.23	3,713	3,372	3,685	3,245	2,930	3,122	3,226	3,437	3,614	4,466	4,619.6	2,940	3,112
Heating surface, superheater, sq. ft.	834	...	...	374	...	...	...	...	...	600	...	...	...	...	...	...	...	...
Grate area, sq. ft.	60.2	99.85	55.13	50.5	56.5	52.7	33.6	49.5	50.4	47.4	51	54	43.5	48.8	51	55.4	31.5	33.3
Firebox, length	120″	126½″	110½″	109″	108⅛″	108⅛″	120½″	108″	108⅛″	95½″	108″	108″	96″	107″	102″	108⅛″	108″	120″
Firebox, width	72¼″	114″	72″	68″	75¼″	70¼″	40½″	66″	67¼″	71¼″	68″	71¾″	65¼″	65¾″	72″	73¼″	42″	40″
Fuel, kind	Bit. coal	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bi coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number firetube	472	493	465	358	446	443	381	413	360	355	386	403	372	366	374	447	564	430
Tubes, number superheater	...	...	...	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Tubes, diameter, firetube	2″	2″	2″	2″	2″	2″	2″	2″	2¼″	2″	2″	2″	2″	2″	2¼″	2″	2″	2″
Tubes, diameter, superheater	...	...	...	5½″	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Tubes, length	16′	14′ 6″	15′	14′ 6″	15′	15′ 2″	16′	16′ 4″	14′ 6″	14′ 11″	14′ 6½″	14′ 6½″	16′ 6″	17′ 6″	19′ 6″	19′ 0″	15′	13′ 0″
Tender, coal capacity, tons	15	14	17.5	14	12	12	14	12.5	...	3,300 G	12	12½	12	14	16	12	10	10
Tender, water capacity, gals.	9,000	7,800	7,000	8,000	7,500	7,500	8,500	8,000	8,000	8,500	7,500	7,500	10,000	8000	9,500	8 000	5,000	7,000
Weight on drivers ÷ tractive effort	4.3	4.3.	4.95	4.41	4.5	4.30	5.10	4.28	4.44	4.17	4 2	4.13	4.38	4.31	4.10	4.86	4.03	4 04
Weight, total ÷ tractive effort	4.8	4.97	5.59	5.03	5.0	4.88	5.72	4.77	5.	4.75	4.76	4.61	5.6	5.80	5.05	4.86	4.03	4.04
T. E. × diam. drivers ÷ total H. S.	825.	700.	689.00	825.00	775.	780.00	730.00	796.00	760.	855.	790.	768.	855.	812.80	631 00	625.	785.00	710.
Total heating surface ÷ grate area	68.50	40.5	69.64	65.00	65.8	70.40	102.00	74.3	64.	62.	61.	59.80	78.8	74.00	87.50	83	93.20	94.
Firebox heat. surf. ÷ total H. S., %	4.80	8.12	4.87	5.80	5.75	5.00	5.82	4 65	5.9	5.35	5.85	5.42	7.12	7.80	4.23	4.25	6.04	6.6
Weight on drivers ÷ total heating surface	56.	53.5	54.96	63.00	55.8	53.90	61.00	54.00	58.	62.50	58.2	56.40	59.6	55.62	46.50	58.3	62.00	57.1
Weight, total ÷ total heating surface	63.	60.8	62.07	71.70	6.25	62.30	67.50	60.40	66.	72.50	66.	63.	75.5	72.21	56 90	58.3	62.00	57.1
Total heat. surf. ÷ superheating heat. surf.	5.	...	...	8.78	...	...	...	...	...	4 90	...	...	...	...	...	...	...	...
Cylinder volume, cu. ft.	22.70	14.4	14.66	18.20	15.4	18.16	13.20	15.6	13.2	16.80	13.2	13 20	15.8	15.70	16.75	14.7	12.35	12.
Total heating surface ÷ cylinder volume	181.	280.	261.89	181.00	242.	204.00	256.00	236.20	246.	174.50	236.5	244.06	218.	230.19	266.00	314.	239.00	260.
Superheating heat. surf. ÷ cyl. volume	36.8	...	...	20.6	...	...	...	...	...	35.5	...	...	...	...	...	...	...	...
Grate area ÷ cylinder volume	2.65	6.92	3.76	2.78	3.66	2.90	2.55	3.18	3.8	2.82	3.87	4.10	2.76	3.10	3.05	3.78	2.55	2.77
Reference in THE AMERICAN ENGINEER	1907 p. 302	1907 p. 22	1910 p. 69	1909 p. 256	1906 p. 263	July 1910	1909 p. 270	1910 p. 64	...	1908 p. 112	1907 p. 194	1908 p. 26	1906 p. 392	1909 p. 305	1909 p. 225	1905 p. 330	1909 p. 360	1906 p. 346

† Includes combustion chamber.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

PASSENGER LOCOMOTIVES OF THE PACIFIC (4-6-2) AND PRAIRIE (2-6-2) TYPES

TYPE	PACIFIC 4-6-2											
Name of road	P. R. R.	N. Y. C.	C. & A.	C.& N.W.	C. & A.	N. P.	G. N.**	C. B. & Q.	A. T. & S. F.	R. F. & P.	N. Y., N.H. & H.	C. B. & Q.
Road number or class	K 28	3565	623	1,500	605	2,175	1,445	2,850	1290	84	I1	S1
Builder	Amer.	Amer.	Amer.	Amer.	Bald.	Amer.	Bald.	Bald.	Bald.	Bald.	Both	....
When built	1907	1908	1909	1910	1908	1906	1909	1909	1908	1907	1907	1906
Simple or compound	Simple	Simple	Simple	Simple	Simple	Comp.	Simple	Simple	Simple	Simple	Simple	Simple
Tractive effort, lbs	30,700	29,200	31,475	31,900	34,500	30,340	35,300	31,100	32,600	31,100	31,560	31,100
Weight, total, lbs	272,500	266,000	248,000	245,000	243,200	240,000	235,750	234,900	232,750	230,800	229,500	228,000
Weight on drivers, lbs	183,900	171,500	149,500	151,000	146,500	157,000	152,000	160,150	140,400	143,750	142,500	150,000
Weight on trucks, lbs	....	....	....	....	47,600	53,000	39,900	37,400	54,950	46,850	46,500	42,000
Weight on trailer, lbs	....	....	....	....	49,100	30,000	43,850	37,350	37,400	40,200	41,000	36,000
Weight, tender loaded, lbs	143,800	164,000	165,120	154,000	161,800	141,350	148,200	155,100	165,200	350,000	134,000	148,200
Wheel base, driving	13' 10"	14'	13' 9"	13' 6"	13' 9"	12' 0"	13'	12' 10"	12' 8"	12' 10"	13' 1"	12' 10"
Wheel base, engine	35' 2¼"	36' 6"	34' 8½"	34' 7"	32' 8"	33' 5"	33' 9"	32' 9"	34' 4¾"	32' 8"	33' 5¼"	32' 9"
Wheel base, engine and tender	67' ¾"	67' 11"	66' 4"	66' 10½"	65' 8½"	62' 10"	66' 7½"	64' 3½"	65' 2"	61' 11½"	61' 2"	64' 3¼"
Diameter of drivers	80"	79"	80"	75"	73"	69"	73"	74"	73"	73"	73"	74"
Cylinders, number	2	2	2	2	2	4	2	2	2	2	2	2
Cylinders, diameter	24"	22"	23"	23"	23"	16½" & 27½"	26"	22"	25"	22"	22"	22"
Cylinders, stroke	26"	28"	28"	28"	28"	26"	30"	28"	28"	28"	28"	28"
Valve gear, type	Wals.	Wals.	Pilloid	Wals.	Wals.	Wals.	Wals.	Wals.	....	....	....	Steph.
Steam pressure, lbs	205	200	200	190	200	220	150	200	160	200	200	200
Boiler, type	Str.	Conical	E. W. T.	E. W. T.	W. T.	E. W. T.	Belp.	W. T.	Str.	Str.	Str.	W. T.
Boiler, smallest diameter	78"	72"	72"	70⅛"	72"	72¼"	72"	70"	72"	74"	70"	70"
Boiler, height center	119"	....	....	116"	113"	115"	111"	109⅜"	114¾"	112½"	110"	109¾"
Heating surface, tubes, sq. ft	4243	3981.6	3869.	4130.	3721.	2667.	2920.	3610.	3202	3917.	3743.	3,732.
Heating surface, firebox, sq. ft	205	228.3	202.	236.	206.	241.8	213.	194.	190	190.	204.4	200.
Heating surface, total, sq. ft	4448	4209.9	4071.	4366.	3927.	2908.8	3133.	3804.	3392	4107.	3947.4	3,932.
Heating surface, superheater, sq. ft	....	....	....	....	....	....	620.	....	....	....	....	....
Grate area, sq. ft	61.86	56.5	49.5	53	33.	43.5	54.15	55.	49.5	49' 5"	53.5	54.
Firebox, length	111"	108⅛"	108"	108¼"	120⅛"	96"	126¼"	108¼"	107⅞"	108"	108⅛"	108⅛"
Firebox, width	80¼"	75¼"	66"	70¼"	40¼"	65¼"	66¼"	72¼"	66"	66"	71¼"	72¼"
Fuel, kind	Bit. Coal	Bit. Coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. Coal	Bit. Coal	Bit. coal.
Tubes, number firetube	343	382	373	396	357	306	160	293	273	318	310	303
Tubes, number superheater	....	....	....	....	....	....	32	....	....	....	....	....
Tubes, diameter, firetube	2¼"	2"	2"	2"	2"	2"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"
Tubes, diameter superheater	....	....	....	....	....	....	5½"	....	....	....	....	....
Tubes, length	21'	20'	20'	20'	20'	16' 9"	21'	21'	20'	21'	20' 6"	21' 0"
Tender, coal capacity, tons	11	14	14	13	12½	12	13	13	33,009	12	14	13
Tender, water capacity, gals	7000	8000	8500	7,500	8,250	7,000	8,000	8,200	8,500	6,000	6,000	8,000
Weight on drivers ÷ tractive effort	6.00	5.84	4.74	4.73	4.26	5.2	4.31	5.17	4.33	4.62	4.5	4.8
Weight, total ÷ tractive effort	8.85	9.11	7.90	7.68	7.05	7.9	6.68	7.55	7.12	7.65	7.25	7.3
T. E. × diameter drivers ÷ total H S	550.00	550.00	618.00	548.00	640.00	720.	822.00	605.00	700.00	560.00	585.00	585.
Total heating surface ÷ grate area	72.00	74.50	82.30	82.40	119.	67.	57.85	69.20	68.50	82.90	73.50	71.3
Firebox heat. surf. ÷ total H.S. %	4.62	5.35	4.98	4.79	5.24	8.3	6.80	5.10	5.60	4.64	5.20	4.85
Weight on drivers ÷ total heat. surf.	41.50	40.70	36.60	34.80	37.30	53.8	48.51	42.40	41.50	34.90	36.20	38.
Weight total ÷ total heating surface	61.20	63.10	61.00	56.20	62.00	82.5	75.24	61.30	68.50	56.10	58.20	58.
Total H.S. ÷ superheating heat. surf.	....	....	....	....	....	....	5.05	....	....	....	....	....
Cylinder volume, cubic feet	13.60	12.32	13.50	13.28	13.00	9.9*	18.50	12.30	16.00	12.30	12.30	12.3
Total heating surface ÷ cyl. volume	326.00	341.00	302.00	328.00	290.00	294.	169.34	310.00	212.00	334.00	321.00	318.
Superheating heating surf. ÷ cyl. vol.	....	....	....	....	....	....	3.40	....	....	....	....	....
Grate area ÷ cylinder volume	4.55	4.58	3.67	3.99	2.44	4.3	2.92	4.48	3.10	4.03	4.20	4.39
Reference in THE AMERICAN ENGINEER	1907 p. 267	1908 p. 164		This Issue	1908 p. 399	1906 p. 411	1909 p. 413	1909 p. 376	1908 p. 112	1907 p. 407	1907 p. 431	1906 p. 300

TYPE	PRAIRIE (2-6-2)					
Name of road	A.T. & S.F.	L.S. & M S.	C. B. & Q.	N. P.	G. N.	Wabash†
Road number or class	1800	4,724	R5	2,378	J1	G1
Builder	Bald.	Amer.	Amer.	Amer.	Bald.	Both
When built	1906	1906	1906	1906	1906	1907
Simple or compound	Comp.	Simple	Simple	Simple	Simple	Simple
Tractive effort, lbs	37,800	27,850	35,060	33,300	37,560	34,558
Weight, total, lbs	248,200	233,000	216,000	209,500	209,000	205,900
Weight on drivers, lbs	174,700	165,200	152,000	152,000	151,000	150,500
Weight on trucks, lbs	31,300	26,000	25,600	....	21,000	21,900
Weight on trailer, lbs	42,200	41,800	38,400	....	37,000	....
Weight, tender loaded, lbs	175,000	159,900	148,200	139,500	151,000	153,000
Wheel base, driving	13' 8"	14' 0"	13' 4½"	11' 0"	13' 0"	13' 4½"
Wheel base, engine	33' 9"	34' 3"	30' 8½"	28' 11"	30' 9"	30' 8½"
Wheel base, engine and tender	65' 0"	62' 5¼"	62' 2¾"	57' 3½"	63' 8"	61' 4¼"
Diameter of drivers	69"	79"	69"	63"	69"	70"
Cylinders, number	4	2	2	2	2	2
Cylinders, diameter	17½" & 29"	21¼"	22"	21"	22"	22"
Cylinders, stroke	28"	28"	28"	28"	30"	28"
Valve gear, type	Wals.	Wals.	Steph.	Steph.	Wals.	Steph.
Steam pressure, lbs	225	200	210	200	210	210
Boiler, type	E. W. T.	E. W. T.	W. T.	E. W. T.	Belp.	E. W. T
Boiler, smallest diameter	76"	70"	70"	72⅛"	72"	70"
Boiler, height center	115"	114"	107⅜"	115"	108"	107⅞"
Heating surface, tubes, sq. ft	3,803.	3,678.	3,375.	2,105.	3,277.	3370
Heating surface, firebox, sq. ft	217.	227.	200.	235.	210.	190
Heating surface, total, sq. ft	4020.	3,905.	3,575.	2,340.	3,487.	3560
Heating surface, superheater, sq. ft	....	....	....	....	....	....
Grate area, sq. ft	53.8	55.	54.	43.5	53.15	54.25
Firebox, length	107⅛"	108⅛"	108⅛"	96"	116"	108⅛"
Firebox, width	71¼"	73¼"	72¼"	65¼"	66"	72¼"
Fuel, kind	Bit. Coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal
Tubes, number firetube	342	322	303	306	301	303
Tubes, number superheater	....	....	....	....	....	....
Tubes, diameter, firetube	2¼"	2¼"	2¼"	2"	2¼"	2¼"
Tubes, diameter superheater	....	....	....	....	....	....
Tubes, length	18' 10⅛"	19' 6"	19' 0"	13' 3"	18' 6"	19'
Tender, coal capacity, tons	14	15	13	12	13	15
Tender, water capacity, gals	9,000	8,000	8,000	7,000	8,000	7,700
Weight on drivers ÷ tractive effort	4.6	4.4	4.3	4.6	4.	4.35
Weight, total ÷ tractive effort	6.6	8.3	6.2	6.3	5.6	5.95
T. E. × diameter drivers ÷ total H S	650.00	565.	677.	900.	746.	680.00
Total heating surface ÷ grate area	74.	71.	64.8	53.8	65.	65.70
Firebox heat. surf. ÷ total H.S. %	5.4	5.8	5.34	10.1	6.0	5.32
Weight on drivers ÷ total heat. surf.	43.5	42.	42.5	65.	43.5	42.20
Weight total ÷ total heating surface	62.	61.	60.7	89.5	60.	58 00
Total H.S. ÷ superheating heat. surf.	....	....	....	....	....	....
Cylinder volume, cubic feet	12.1*	11.7	12.3	11.2	13.2	12.32
Total heating surface ÷ cyl. volume	334.	335.	290.	209.	265.	290.00
Superheating heating surf. ÷ cyl. vol.	....	....	....	....	....	....
Grate area ÷ cylinder volume	4.43	4.68	4.46	3.89	4.03	4.41
Reference in THE AMERICAN ENGINEER	1906 p 435	1906 p. 204	1906 p. 300	1906 p 392	1906 p.365	1908 p.31

* Equivalent simple cylinders.
** With superheater.
† Designed for fast freight service.

A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

PASSENGER LOCOMOTIVES OF TYPES OTHER THAN THE PACIFIC AND PRAIRIE

TYPE	ATLANTIC (4-4-2)									TEN WHEEL (4-6-0)							AMERICAN (4-4-0)	
Name of road	U. P.	Erie	C. M. & St. P.	P. R. R.	N. Y. N. H. & H.	N. P.	C. B. & Q.	Har. Lines	C. R. I. & P.	B. & A.	S. P.	D. L. & W.	C. G. W.	N. Y. C.	N. C. & St. L.	C. & N. W	C. R. R. of N. J.	D. L. & W.
Road number or class	21	537	951	2,760	F1	603	P3	A-81	1,019	1,916	2,317	1,012	500	2,099	284	....	852	955
Builder	Baldwin	Amer.	Bald.	Amer.	Amer.	Bald.	Bald.	Bald.	Amer.	Amer.	Bald.	Amer.	Bald.	Amer.	Bald.	Amer.	Amer.	Amer.
When built	1906	1905	1907	1905	1907	1909	1904	1905	1905	1908	1907	1905	1909	1905	1908	1907	1905	1905
Simple or compound	Comp.	Comp.	Comp.	Comp.	Simple	Simple	Comp.	Simple	Simple	Simple	Simple	Simple	Simple	Simple	Bal.comp	Simple	Simple	Simple
Tractive effort, lbs	24,281	23,860	22,200	23,300	24,670	24,760	21,400	23,560	24,700	31,000	36,570	35,100	33,060	31,000	29,200	30,900	23,120	23,710
Weight, total, lbs	209,000	206,000	204,119	200,500	200,000	197,050	196,600	196,000	191,300	208,000	203,300	201,000	198,050	194,500	181,400	179,500	161,300	151,200
Weight on drivers, lbs	110,000	115,000	105,966	117,200	105,500	100,800	101,200	105,000	107,100	158,000	160,000	154,000	144,950	148,000	134,000	135,500	111,300	100,000
Weight on trucks, lbs	53,000	52,000	52,353	52,500	48,000	51,950	54,200	45,000	42,400	....	....	47,000	53,100	46,500	47,400	44,000	50,000	51,200
Weight on trailer, lbs	46,000	39,000	45,800	30,000	46,500	44,300	41,200	46,000	40,800	155,800	43,300	....	....	....	....	....	....	....
Weight, tender loaded, lbs	162,200	162,800	130,000	132,500	134,000	122,950	120,400	162,200	144,000	....	141,366	120,000	144,000	143,500	118,000	139,500	122,200	110,000
Wheel base, driving	7′ 0″	7′ 0″	7′ 6″	7′ 5″	7′ 3″	6′ 10″	7′ 3″	7′ 0″	7′ 0″	15′ 10″	13′ 10″	14′ 4″	15′ 3″	15′ 10″	12′ 0″	14′ 10″	8′ 3″	8′ 6″
Wheel base, engine	27′ 10″	28′ 0″	32′ 2″	31′ 11″	28′ 2″	27′ 10″	30′ 2″	27′ 7″	27′ 5½″	26′ 10½″	25′ 10″	25′ 6″	27′ 1″	26′ 10½″	26′ 0″	25′ 10″	23′ 1½″	24′ 5″
Wheel base, engine and tender	58′ 5″	60′ 9″	66′ 9″	61′ 4″	56′ 1″	57′ 3″	57′ 6¾″	58′ 2″	57′ 2″	59′ 3″	58′ ¼″	54′ ¼″	57′ 9½″	59′ 2″	55′ 2″	57′ 9″	49′ 2″	51′ ⅝″
Diameter of drivers	81″	78″	85″	80″	79″	73″	78″	81″	73″	69″	63″	69″	73″	69″	66″	63″	69″	69″
Cylinders, number	4	4	4	4	2	2	4	2	2	2	2	2	2	2	4	2	2	2
Cylinders, diameter	16″ & 27″	15½ & 26″	15″ & 25″	16″ & 27″	21″	21″	15″ & 25″	20″	21″	22″	22″	21½″	26″	22″	16″ & 27″	21″	19″	20″
Cylinders, stroke	28″	26″	28″	26″	26″	26″	26″	28″	26″	26″	28″	26″	28″	26″	26″	26″	26″	26″
Valve gear, type	Wals.	Steph.	....	Steph.	....	Wals.	Steph.	Steph.	Steph.	....	....	Steph	Wals.	Steph.	Wals.	Wals.	Steph.	Steph
Steam pressure, lbs	200	220	220	205	200	185	210	200	185	200	200	215	150	200	210	200	200	185
Boiler, type	Str.	E. W. T.	W. T.	Belp.	E. W. T.	Str.	E. W. T.	Str.	Str.	E. W. T.	W. T.	Str.	Str.	W. T.	W. T.	E. W. T.	W. T.	Str.
Boiler, smallest diameter	70″	70¾″	66″	65⅝″	68″	72⅛″	64″	70″	72″	72⅛″	72″	74⅝″	70″	70⅝″	64″	66⅜″	62¼″	61¾″
Boiler, height center	113″	111⅜″	114″	109″	110″	....	108⅛″	113″	108″	115″	102″	116½″	....	115″	107″	....	113″	....
Heating surface, tubes, sq. ft	2475.	3453.6	3008.	2680.2	3041.	2112.	3050.5	2475.	2227.6	3104.5	2788.	3156.3	2,206	3124.7	2550	2808.4	1838.1	1947.9
Heating surface, firebox, sq. ft	180.	181.1	168.	181.4	204.4	173.	155.5	174.	161.8	203.3	206.	221.7	149	202.7	185	150.8	167.6	190.8
Heating surface, total, sq. ft	2655.	3634.7	3194.	2861.6	3245.4	2285.	3206.	2649.	2389.4	3307.8	2994.	3378.	2,355	3326.7	2735	2959.2	2005.7	2138.7
Heating surface, superheater, sq. ft	....	....	....	....	....	480.	....	....	338.	....	....	....	460	....	....	....	....	....
Grate area, sq. ft	49.5	56.5	45.	55.5	53.5	43.5	44.1	49.5	44.8	54.9	32.1	94.8	49.5	54.93	34.8	46.27	81.6	87.54
Firebox, length	108″	108⅛″	107″	111″	108⅛″	96″	96⅛″	108″	96″	105⅛″	124″	126⅛″	108″	108⅛″	120″	102⅛″	122⅛″	126 3/16″
Firebox, width	66″	75¼″	60⅛″	72″	71¼″	65¼″	66¼″	66″	67¼″	75¼″	37¼″	108¼″	66⅓″	75¼″	41⅞″	65¼″	96¼″	100″
Fuel, kind	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Anth. coal	Anth. coal
Tubes, number firetube	297	388	268	315	347	196	264	297	173	400	355	398	203	400	256	337	280	280
Tubes, number superheater	....	....	....	....	....	22	....	....	54	....	....	....	24	....	....	....	....	....
Tubes, diameter, firetube	2″	2″	2¼″	2″	2″	2″	2¼″	2″	2″	2″	2″	2″	2″	2″	2¼″	2″	2″	2″
Tubes, diameter, superheater	....	....	....	....	....	5⅜″	....	....	3½″	....	....	....	5″	....	....	....	....	....
Tubes, length	16′ 0″	17′ 0″	19′	16′ 3″	16′ 10″	16′	19′ 0″	16′ 0″	16′ 0″	14′ 11″	15″	15′ 3″	16′	14′ 11″	17′	16′ 0″	12′ 6″	13′ 4¼″
Tender, coal capacity, tons	10	16	10	12½	14	9	12	10	12	12	2,940	10	12½	12	10.5	10	12	10
Tender, water capacity, gals	9,000	8,500	7,000	5,500	6,000	6,000	6,000	9,000	7,000	8,000	7,000	6,000	8,000	7,000	5,500	7,500	5,000	5,000
Weight on drivers ÷ tractive effort	4.53	4.82	4.75	5.	4.27	4.05	4.7	4.48	4.2	5.10	4.37	4.38	4.38	4.77	4.58	4.38	4.8	4.22
Weight total ÷ tractive effort	8.6	8.63	9.20	8.6	8.10	7.95	9.2	8.35	7.8	6.70	5.57	5.72	5.99	6.27	6.27	5.80	6.95	6.4
T. E. × diam. drivers ÷ total H. S.	740.	513.	610.	650.	600.	790.	518.8	717.	754.	647.	770.	717.	1024.	647.	705.	655.	800.	765.
Total heat. surf. ÷ grate area	53.8	64.3	70.50	51.6	60.50	52.30	73.	53.6	53.3	60.20	93.	35.6	47.50	60.5	78.50	64.	24.7	24.4
Firebox heat. surf. ÷ total H. S. %	6.8	5.	5.30	9.37	6.30	7.60	4.85	6.6	6.75	6.15	6.90	6.6	6.30	6.1	6.80	5.10	8.4	8.9
Wgt. on drivers ÷ total heat. surf	41.5	31.7	33.10	41.	32.60	43.80	31.5	39.6	44.8	51.	53.40	45.6	61.50	44.5	49.00	45.75	55.3	46.8
Wgt. total ÷ total heat. surf	78.9	56.8	64.	70.	61.80	79.50	61.3	74.	80.	67.	68.	59.8	81.10	58.7	67.00	60.50	80.5	71.
Total H. S. ÷ superheating heat. surf	....	....	....	....	....	4.76	....	....	7.08	....	....	....	5.10	....	....	....	....	....
Cylinder volume, cu. ft	10.2†	8.93†	9.†	10.2†	10.40	10.40	8.3†	10.2	10.4	11.40	12.30	10.9	17.20	11.4	10.20	10.4	8.6	9.5
Total heat. surf. ÷ cyl. vol	262.	408.	355.	280.	311.	219.00	387.	260.7	230.	288.	243.	311.	136.90	292.	268.00	287.	233.	224.
Sup. heat. surf. ÷ cyl. vol	....	....	....	....	....	46.20	....	....	32.5	....	....	....	26.70	....	....	....	....	....
Grate area ÷ cyl. vol	4.83	6.27	5.	5.42	5.16	4.19	5.3	4.85	4.3	4.8	2.61	8.68	2.88	4.8	3.40	4.45	9.5	9.2
Reference in THE AMERICAN ENGINEER	1906 p. 308	1905 p. 287	1908 p. 37	1906 p. 73	1907 p. 471	1909 p. 195	1904 p. 212	1905 p. 154	1905 p. 329	....	1907 p. 481	1905 p. 407	1910 p. 64	1906 p. 59	1909 p. 52	1907 p. 247	....	....

† Equivalent Simple Cylinders.

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* Illustrated articles.

THE CONVENTIONS

This year's conventions at Atlantic City, in the value of the committee reports, the size and attractiveness of the exhibit and the interest taken in the proceedings in the convention hall, were fully up to the standard of previous years. The discussions on committee reports and individual papers were not as active or prolonged as might have been expected or as was evidently anticipated. This was particularly noticeable in the Master Car Builders' Association, where it was found to be unnecessary to hold two daily sessions as had been planned. Many of the reports before this association were accepted with thanks and referred to letter ballot without any discussion or argument, although it would have seemed as if there was an opportunity for a very decided difference of opinion in several of them. All of the reports before this association were good and several of them were of unusual value.

In the Master Mechanics' Association, however, there was no evidence of lack of interest or paucity of decided opinions on the subjects brought up and in several cases the discussion became very active and even heated. The papers before this association were also of very high grade, particularly the individual paper on "Freight Train Resistance" by Professor Schmidt, which is a contribution to the proceedings of this association of unusual value.

In the M. C. B. convention the subject that received the most active discussion was the report of the committee on consolidation. There is evidently a quite natural and very decided disinclination among the more prominent members of this association to terminate its existence and strong arguments were advanced in support of this position. It would seem, however, to a disinterested observer as if the predominating weight of the argument favored the consolidation of the two associations. The committee report, which is given in another part of this issue, presented the subject in a very clear manner, and on the whole, although no definite recommendations were made by these committees, it favored the consolidation into an entirely new association. The whole matter, however, was very sensibly laid on the table for another year and it is probable that by the time of the next meeting the majority of members will have come to some conclusion that will permit at least the start of a movement which will eliminate the difficulties now existing.

The formation of a permanent technical bureau composed of active members of the association having thorough technical training, together with the officers of the association as members ex officio, was advocated by President Wildin in his address. He suggested that one member of this bureau be a salaried incumbent with a compensation which would permit a man fully equipped through experience and training to accept it. It was suggested that this bureau be clothed with authority to act for the associations on all important quesions coming up between the annual meetings and that it make a report of its activities to the associations at the next annual meeing. There is no doubt but what there is much work that such a bureau could handle to excellent advantage and the developments during the past year, particularly in connection with government activity on railroad questions, show the very great necessity for having some body of this character which can act as an official mouthpiece for the whole association on technical questions. Although no action was taken by the convention on this suggestion it was received with favor by many of the members and no doubt something of the kind will be done in the near future.

Saratoga is making a strong effort to have the meetings of the associations again held at that point and are prepared to present to the executive committees what they consider to be a very attractive proposition to bring it about. Among the members of the associations and of the Supply Men's Association there seem to be many who strongly favor returning to Saratoga for the next meeting and no doubt the arguments of the committee from that village will be seriously considered by the executive committees.

MASTER CAR BUILDERS ASSOCIATION

FORTY-FOURTH ANNUAL CONVENTION.

ABSTRACTS OF COMMITTEE REPORTS AND PROCEEDINGS OF THE CONVENTION.

The first session of the forty-fourth convention was opened on Young's Million Dollar Pier, Atlantic City, N. J., on Wednesday, June 15, 1910, by President F. H. Clark, general superintendent of motive power, Chicago, Burlington & Quincy Railroad.

Following the address of welcome by Mayor Stoy, which was acknowledged by Past President W. E. Fowler, the president delivered his address.

President's Address.—After greeting the members, Mr. Clark drew attention to a number of matters in connection with the work of the association about which the members had not been informed, saying in part:

"One of the most important of these seems to be the present status of the safety appliance question as reported in full by our safety appliance committee. Congress passed a bill about two months ago, which received the signature of the President, and which provides that within six months from its passage the Interstate Commerce Commission, after hearing, shall designate the number, dimensions, location and manner of application of sill steps, hand-brakes, ladders, running boards and other parts mentioned in previous safety appliance acts. This bill provides that the rulings of the Interstate Commerce Commission shall be effective July 1, 1911, and that the commission may, upon full hearing and for good cause, extend the time after which any common carrier may be required to comply with the provisions of the act. The commission is also given authority, after hearing, to modify or change, and to prescribe the standard height of drawbars and to fix the time within which modification or change shall become effective. It was suggested about the time the bill passed that the hearing could be materially shortened and better results obtained if a conference was arranged between a committee of your association and the inspectors of the Interstate Commerce Commission, they to represent the commission; and, as the idea met with favor by Mr. Moseley, secretary of the Interstate Commerce Commission, and your executive committee, a special committee was appointed for the purpose. The American Railway Association authorized this committee to give such attention as might be necessary to the question of drawbar heights, a matter that had previously been handled by that association. A preliminary meeting on the whole subject was held on May 24, and subsequent meetings on June 6, 7 and 8, and, as a member of that committee, I would like to testify to the fairness and earnestness of purpose evidenced on both sides. I think it very likely that the final result will be a considerable expenditure of money on the part of the railways in bringing old equipment up to the desired standards, but it seems likely that at the public hearing the Interstate Commerce Commission will grant the railways reasonable time to make their existing cars comply with the rules which they will prescribe. A public hearing on height of drawbars was held by the Interstate Commerce Commission on the 7th of the month, and it is understood that an order will probably be issued prescribing 34½ inches as the maximum height and 31½ inches as the minimum height of couplers on standard gauge freight equipment, 26 inches as the maximum and 23 inches as the minimum height on narrow gauge freight equipment, except for two-foot gauge, where a maximum height of 17½ inches and a minimum height of 14½ inches is proposed.

This, I believe, will clear up the misunderstanding as to the intent of the present law, which has been given an interpretation somewhat at variance with the ideas of its framers.

It is probable that the public hearing on other details will be postponed until the early fall in order that the conference committees may be given all the time that will be necessary in which to reach their final conclusions. If in the end there are any points of difference between the office of the commission and the representatives of the railways, they will no doubt be settled by the commission at that time.

As I have already suggested, the orders of the commission may involve the railways of the country in considerable expense, this on account of the lack of uniformity in the application of safety appliances to our cars, and this is largely due to the fact that in some cases our safety appliance rules have not, until recently, covered some types of construction with sufficient clearness. Unfortunately, also, the association has not been in a position to enforce its rules, so that some variations have been allowed to continue which should have been corrected. The whole matter is now in the hands of the Interstate Commerce Commission, and your committee may regard itself, I suppose, as an advisory committee to that body. Where questions of safety are clearly involved there cannot very well be any serious differences of opinion, but the committee will take occasion to urge upon the officers of the commission the injustice of requiring uniformity when not essential to safety."

Following this, he drew attention to the fact that but a single case of the abuse of the repair card had been brought to the attention of the association during the year. A number of claims of sharp practice had been investigated and definitely disproved.

In connection with the report of the committee on consolidation the president said: "This is an important matter and one which should not be settled without a full comprehension of the points at issue. The matter has been proposed before, but the subject has never been brought to the point at which it now stands. I hope that it will receive your most careful consideration and that we shall all approach the subject without prejudice."

The death of the following members was reported: J. J. Ellis, P. H. Peck and J. F. Devine.

It was also announced that owing to the fact that the Master Car Builders' Association is an unincorporated body it will probably be unable under the laws of the State of New York to receive the Tilletson legacy of $5,000, bequeathed by the widow of a former member of the association.

SECRETARY'S REPORT.

Membership—Active, 377; representative, 332; associate, 14; life, 19; total, 742. Number of cars represented, 2,298,633.

Financial—Income, $16,509.50; expenses, $15,919.20; balance, $590.21. The balance now in the treasury is $1,127.82.

During the year fourteen railway and private car lines have signified their desire to become subscribers to the rules of interchange governing freight cars. Nine railways and private car lines have accepted the code of rules governing the interchange of passenger equipment.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year:

T. H. Curtis, president.

A. Stewart, C. E. Fuller and D. F. Crawford, vice-presidents.

John S. Lentz, treasurer.

J. D. Harris, C. E. Fuller and C. A. Seley, members of the executive committee.

J. F. Deems, A. W. Gibbs, C. A. Seley, W. H. Lewis and J. F. Walsh, committee on nominations.

RULES FOR LOADING LONG MATERIALS

The committee recommended a number of changes in the rules, all of which were referred to letter ballot with the exception of the sections referring to fixing the center of gravity of superimposed loads at 9 ft. 3 in. and the use of metal spacing blocks.

REVISION OF THE RULES OF INTERCHANGE.

Most careful study and consideration in effecting all the improvement possible in the code of rules was evident in the committee's report. Changes of varying importance were made in a large number of the rules and a rearrangement of all rules to bring related parts closer together were presented.

The report of this committee was accepted with a rising vote of thanks and will be submitted to letter ballot.

A letter from W. H. Lewis on the subject of the abuse of the repair card was read by the secretary. After a brief discussion, which developed the fact that there had been a big improvement in this respect during the year, a motion was carried to the effect that all members submit to the executive committee by letter any cases of abuse of the repair card that come to their notice.

SAFETY APPLIANCES.

Committee:—C. A. Seley, chairman; A. LaMar, T. H. Curtis, C. B. Young, H. Bartlett and T. M. Ramsdell.

The committee regrets having no report for this year, account of pending legislation in the matter of safety appliances. The status of the matter is as follows: During the present session House Bill 5702, passed last year in the house, was taken up, and, after a number of amendments, was passed by both houses and signed by the President, thereby becoming a portion of the Interstate Commerce Law.

Section 2 of the law brings more of the details of cars under scrutiny than was called for in the old acts, namely, sill steps, hand brakes, ladders, running boards and roof handholds. A proviso is also added, covering the case of loading of long commodities requiring more than one car, and it is also understood that hand brakes are not required on logging cars and other vehicles exempted by the primary acts.

Section 3 authorizes the Interstate Commerce Commission to designate the number, dimensions, location and manner of application of the appliances covered by these acts after notice and hearing. Inasmuch as the hearing has not been held, the committee has no definite information as to whether the M. C. B. standards will be acceptable to the Interstate Commerce Commission or not, and until such hearings definitely decide on this point, the committee has felt that any efforts on their part might be wasted labor.

Section 4 provides for movement of bad-order cars for repairs as has been a practical necessity in the past, although such movements would be illegal were the laws strictly construed. The new arrangement gives welcome relief in this respect by permitting the car to be hauled to the nearest available repair shop without liability, except in case of danger to employees during such movement, which is properly provided for.

It is quite possible that special instructions will be issued by the executive committee or by this committee under instructions of the executive committee after the Interstate Commerce Commission hearings have been held and the safety appliances defined.

The report of the committee was adopted, and the executive committee was directed to send a statement to all members fully explaining the position taken by the Interstate Commerce Commission on the matter of standards.

REVISION OF STANDARDS AND RECOEMMNDED PRACTICE.

Committee:—R. L. Kleine, chairman; Jno. Hair, T. M. Ramsdell, W. E. Dunham, and T. H. Goodnow.

The committee recommended changes in the following parts:

STANDARDS.

Standard Axles—Fillets at back end of journal.

Brake Beams—Revision of text.

RECOMMENDED PRACTICE.

Limit gauges for inspecting second-hand wheels for remounting be advanced to a standard.

Brake Beams—Advancing to standard the following: "That brake beam hanger brackets shall be attached to some rigid portion of the truck."

Carrier Iron—Advancing to standard the following and changing title to "Brake Staff Carrier Iron": Use of U shape carrier iron on new cars.

Knuckle Throwing Device—Advancing to standard after Sept. 1, 1911, the following: "That the use of a knuckle-throwing device which will throw the knuckle completely open and operate under all conditions of wear."

The adoption of the following: Doors, door jambs and all other inside exposed corners of stock cars to be rounded to prevent injury to cattle. Add cut to sheet M. C. B.—F. showing the construction.

Committee recommends the appointment of a special committee to determine whether any changes in the present limits for round iron are necessary, and, if so, to fix new limits. This matter requires investigation before establishing any new limits, on account of the effect increased limits would have upon the standard screw threads used.

Discussion—After some discussion the recommendations of the committee in connection with roof boards were eliminated from the report, which was then accepted. A motion to eliminate the reference to gauge for second-hand wheels was lost.

CLASSIFICATION OF CARS.

Committee:—J. Milliken, Chairman, F. M. Whyte, J. N. Mowery.

At the meeting of the American Railway Association, held April 22, 1908, the following resolution was adopted:

"*Resolved*, That the Master Car Builders' Association be requested to take up the question of harmonizing the terms used in designating the different classes of cars and the different kinds of cars in each class, according to their physical characteristics, and report its recommendations to this Association for final action."

The committee feels that the American Railway Association desired a classification of cars more from a transportation, than a detail construction, standpoint, and therefore, presents a Classification of Cars, divided, first, into Passenger Equipment Cars; second, Freight Equipment Cars; third, Maintenance of Way Equipment Cars; and these classes, in turn, subdivided into distinctive classes of cars, principally in order to facilitate the work of car distribution and car efficiency.

We have not taken into consideration the individual physical characteristics, such as kind of trucks, draft gear, or other details of construction of a car, as we understand the principal questions to be answered are "what kind of a car" and "how much will it carry."

The rolling equipment of forty-three railroads, operating 117,500 miles of track, and owning, approximately, 1,350,500 cars, has been looked into, and it is found to be impracticable to make a definite classification giving the individual characteristics of the cars that would, in any way, be applicable to the equipment of the various railroads of the United States.

It would, therefore, seem that the classification should be broad in its interpretation, and confined only to kind of car of general class and the stenciled capacity of the car. With passenger cars, the kind of car, and length and seating capacity should be indicated, and possibly the manner of lighting.

In arriving at the proposed classification of cars a single designating letter has been given for the general service of the car and a secondary letter to cover the general type of the car. In arriving at the primary and secondary letters, the attempt has been made, as far as practicable, to give letters which give some indication of the type of the car, or letters that are now generally used.

DEFINITIONS AND DESIGNATING LETTERS OF GENERAL SERVICE PASSENGER EQUIPMENT CARS.

CLASS "B."

"BA"—Baggage Car. A car run in passenger service, having wide side doors for the admittance of baggage, with or without windows or end doors.

"BE"—Baggage Express. A car similar to baggage, used for either baggage or express matter.

"BH"—Horse or Horse and Carriage Express. A car run in passenger service for the transporting of fine stock, fitted with stalls (movable or stationary) and space left for carriage or horse equipment.

"BR"—Refrigerator Express. A car run exclusively in passenger service and fitted with ice bunkers or boxes, and suitable to carry produce, oysters, fish, or any commodity requiring icing in transit.

"BX"—Express Car. Exclusively for express matter, having suitable side doors, with or without end doors or windows.

CLASS "C."

"CA"—Combined Car, Baggage and Passenger. A car having two compartments, one suitable for transporting baggage, the other fitted with seats for passengers, the two compartments separated by bulkheads.

"CS"—Combined Smoking and Baggage Car (Club Car). A car having two compartments, separated by bulkheads, one compartment suitable for transporting baggage, the other fitted with seats or chairs and used as smoking car; at times equipped with buffet or bar.

"CO"—Combined car having three separate compartments, separated by bulkheads, one compartment suitable for transporting baggage, one for mail fitted with suitable apparatus for sorting and classifying mail, and the other fitted with seats for the transportation of passengers.

"CB"—Business Car. A special type of car for the convenience of business men, used as smoker and fitted with tables or desks, carrying stationery and fitted with typewriters and carrying regular stenographers.

CLASS "D."

"DA"—Dining Car. Regular dining car, for the use of passengers in transit, fitted with regular kitchen, tables, chairs or seats, with or without bar, carrying cooks and waiters.

"DB"—Buffet Car. Car for the transportation of passengers and fitted with small broiler or buffet to serve simple meals to passengers; cooking and serving done on removable tables by regular porter in charge of car. With or without facilities for serving liquor.

"DC"—Café Car. A car fitted with kitchen, usually in center of car, one end used as café where meals are served, also liquor and smoking allowed, the other end of car fitted with either regular dining room or smoking and card room; carrying cooks and waiters.

"DG"—Grill Room Car. Very similar to café car.

"DO"—Café Observation Car. Car fitted with café at one end, kitchen in center or extreme end, having observation compartment fitted with stationery or movable tables and observation platform at rear.

"DP"—Dining and Parlor Car. A car fitted with dining compartment, kitchen and compartment for passengers, fitted with chairs, stationary or otherwise, carrying regular cooks and waiters.

CLASS "E."

"EA"—Electric Street Railway Service Car, direct current, for transportation of passengers; without automatic couplings.

"EP"—Electric Passenger Car; for long hauls or suburban service, multiple unit and fitted with automatic couplings and air brakes. Third rail, trolley or pantagraph contact.

"EB"—Electric Baggage Car, for long hauls or suburban service, multiple unit with automatic couplings and air brakes and suitable for the transportation of baggage. Third rail, trolley or pantagraph contact.

"EM"—Electric Mail Car, for use in United States Mail Service, fitted with side doors, with or without mail hook, and suitable apparatus for the sorting and classifying of mail en route. With or without end doors or windows.

"EC"—Electric Combined. A car for long hauls or suburban service, multiple unit with automatic couplings and air brakes. This car is made up of two compartments, separated by bulkhead, one suitable for the transportation of baggage and the other fitted with seats or chairs for the use of passengers. Third rail, trolley or pantagraph contact.

"EG"—Gasoline Motor Propelled Car, for inspection or private use, or use in suburban service, hauling one or more trailers.

"ED"—Gasoline Motor Car. Gasoline engine or engine serving to run dynamo to furnish electricity for axle motors. Car to be used for inspection, private use, or as motive power to haul trailer or trailers; fitted with storage cells and with or without booster.

CLASS "M."

"MA"—Postal Car. For use of United States Mail Service, fitted with side doors, with or without mail-bag hook, and having suitable apparatus for the sorting and classifying of mail in transit, with or without end doors or windows.

"MB"—Baggage and Mail. A car having two compartments, one for baggage and one for mail, separated by bulkheads; the mail end fitted with suitable apparatus for sorting and classifying mail, and with or without mail-bag catchers, with or without end doors or windows, and having suitable side doors.

"MP"—Postal Car. Suitable for transporting newspapers or large mail packages for United States Mail Service, having side doors and fitted with stanchions, with or without end doors or windows.

"MR"—Postal Storage Car. For United States Mail Service, suitable to carry mail in bulk, without appliances for sorting or classifying, fitted with side doors and stanchions and with or without end doors or windows.

"MS"—Mail and Smoker. A combined car having two separate compartments, separated by bulkheads, one compartment suitable for the transportation, sorting and classifying of mail, the other fitted with seats or chairs to be used by passengers as smoking car.

CLASS "P."

"PA"—Passenger Car. A car for ordinary short haul suburban service, with seats and open platforms.

"PB"—Passenger Car. A vestibule (wire or narrow) car for through service, fitted with seats or reclining seats, and having toilet rooms for men and women, also wash basins.

"PE"—Emigrant or Colonist Car. A second-class passenger car, with floors either bare or fitted with matting, used expressly for emigrant trade on trains where low rate of fare is charged.

"PS"—Sleeping Car. A car for passenger service having seats that can be made up into berths, and usually having one or more separate stateroom compartments, also toilet and washroom facilities for men and women, and smoking compartment for men. Some cars of this class are all compartments, and some compartments and observation combined.

"PN"—Passenger car used exclusively as smoking car, with seats or chairs and fitted with cuspidors or having matting or bare floor.

"PO"—Observation Car. A car having observation compartment at one end and fitted with either berth facilities, parlor chairs or compartments, usually run in first-class service.

"PV"—Private car used as officers' or private individual's car and railroad pay car—usually composed of sleeping compartments, dining compartments, observation end and with kitchen, servant's quarters and toilet and bathroom.

"PT"—Tourist Car. A second-class sleeping-car, fitted usually with cane seats convertible into berths and used mostly on trans-continental trains; cars fitted with smoking compartment, toilet and washroom.

"PC"—Passenger, Parlor or Chair Car. A car fitted with individual stationary or movable chairs, used on trains for daylight runs and having toilet and washrooms.

CLASS "I."

"IA"—Instruction Cars for use of employees, usually run from one point to another in passenger trains.

Note.—If it is to be desired, a small letter "E" can be placed after the larger designating letters to indicate electric lighting, and small "G" for gas lighting, also figures showing approximate length of car or length of baggage or mail compartment.

GENERAL SERVICE FREIGHT EQUIPMENT CARS.

CLASS "X."

"XM"—Box Car. General service, suitable to lading which should be kept from the weather. A box car is a closed car having side and end housings and roof, with doors in sides or sides and ends.

"XA"—Automobile Car. Box car of similar design to general service car, having exceptionally large side doors or end doors.

"XF"—Furniture Car. Box car of similar design to general service car, except usually greater capacity in cubic feet.

"XV"—Box Car, Ventilated. Similar to ordinary box, only having ventilation, and suitable for the transportation of produce or other foodstuffs not needing refrigeration.

CLASS "R."

"RM"—Refrigerator or Produce Car. A car suitable for carrying commodities that need icing in transit. This car is equipped with two or more ice bunkers or baskets and suitable means of draining off melted ice or briny water. This car has side and end housings, roof and side doors, usually insulated, with trap doors in roof for admittance of ice and salt; also water seals inside of car.

CLASS "S."

"SM"—Stock Car. This car is for transportation of stock on the hoof, and is equipped with roof, slatted sides and side doors, and single or double deck. With or without feed or feed and water troughs.

"SD"—Stock Car. Composite having drop doors in floor and means of housing in sides and making drop-bottom box car.

"SP"—Stock Car. Used in poultry trade, fitted with roofs and sides usually of wire netting, fitted with shelves for storing crates of poultry and leaving space for poultrymen, feed bag and watering facilities.

CLASS "G."

"GA"—Gondola Car. This car has sides and ends open at top, and drop bottom; suitable for general coal or ore trade, stone or general trade.

"GE"—Gondola car having drop bottoms and drop sills; suitable for general coal or ore or mill trade.

"GC"—Gondola Coke Car. Gondola car fitted with coke racks and having drop bottoms.

"GD"—Gondola car having side-dump arrangement.

"GM"—Gondola Car. Suited to mill trade, having solid bottom, low sides and drop ends to facilitate twin shipments.

CLASS "H."

"HM"—Hopper Car. Similar in general design to gondola car, having sides and bottom ends and open at top, equipped with hopper bottom and self-cleaning.

"HT"—Hopper (Twin). Similar to ordinary hopper, only equipped with two or more hopper doors instead of one.

"HD"—Hopper car equipped with side-dump hoppers.

"HC"—Hopper car equipped with coke racks.

CLASS "F."

"FM"—Ordinary flat car for general service. This car has flooring laid over sills and without sides or ends.

"FG"—Flat or gun truck car for special transportation of heavy ordnance.

"FW"—Flat well-hole car for special transportation of plate glass, etc. This car is a flat car with hole in middle to enable lading to be dropped down on account of clearance limits.

"FB"—Flat car having skeleton superstructure, suitable for carrying barrels, known as "Barrel Rack Car."

"FL"—Flat logging car or logging truck. This is either an ordinary flat car, or car consisting of two trucks fitted with cross supports over truck bolsters; the trucks connected by a skeleton of flexible frame and logs loaded lengthwise on cross supports.

CLASS "T."

"TM"—Tank car for general service. This car is for general oil or liquid service, and consists of a steel tank mounted on frame or mounted directly on cradles over truck bolsters. It is equipped with one or two safety release valves, and is emptied by valves or valve at bottom. At the top is a dome, with or without manhole, and openings through which the tank may be filled.

"TA"—Acid Tank. Of same general construction as oil tanks.

"TG"—Tank car having glass or glass-lined tanks, for use in hauling mineral waters and other special products.

"TS"—Tanks for special commercial service.

"TW"—Tank car having wooden tank, instead of steel, and used for water, pickles, etc.

CLASS "N."

"NM"—Freight train service caboose for convenience of trainmen. This caboose is mounted on four wheels and has lookout at top over roof. It is fitted with bunks or benches and a stove for cooking and heating purposes, also tank for storage of drinking and washing water, and small tool storage boxes.

"NE"—Caboose mounted on eight wheels and longer than four-wheel caboose, but of the same general design.

CLASS "Y."

"YM"—Yard Poling Car. This car used in hump classification and flat-yard classification. This car is usually fitted with small house for protection and benches, tool box and stove, a counterweighted pole on each side and running board or step near the ground for convenience of yardmen. It is protected with safety appliances and, when in use, coupled to an engine.

"YA"—Yard pick-up car for use of car droppers and yardmen in performance of their duty. It might be termed a "Car Dropper's Car." It is protected by a house, around which runs a platform and railing, a long running board on sides near ground and is fitted with benches, tool box and stove.

NOTE.—The capacity of car can be shown by affixing two figures after designating letter: for instance, "80" would mean 80,000 pounds capacity; "10" would mean 100,000 pounds capacity; "60" would mean 60,000 pounds capacity. Where tanks are in question the capacity numbers should indicate capacity in gallons instead of pounds.

GENERAL SERVICE MAINTENANCE OF WAY EQUIPMENT CARS.

"MWB"—Ballast Cars. All descriptions of cars used for the purpose of carrying ballast for the laying of new right of way and repairs. The car used generally for this work is of the gondola type, with side or center dump.

"MWD"—Dump Cars. On the type of contractors' car used for building up fills; the body of the car dumps, being raised by means of counterweight, air or hand power.

"MWF"—Flat Car. Used for transporting rails, ties or ballast and for storage of wrecking trucks, or gathering scraps along right of way. These cars are at times equipped with low sides, about 10 or 12 inches high.

"MWS"—Steam Shovel. Car equipped with donkey engine housed in. Having a boom of wood or steel and the end of which is a shovel or scoop. It may be propelled by its own power or by means of a locomotive and run as a car in freight trains, being equipped with safety appliances. The cubic capacity of shovels, in yards, can be indicated by figures after classification letters.

"MWW"—Wrecking Derrick. A derrick used for wrecking purposes, having donkey engine to raise and lower booms and hoists; engine housed in and on separate platform with boom, is pivoted in center of car frame in order that it can be worked on either sides or ends; usually fitted with anchor beams to be used for heavy lifting. Fitted with safety appliances and propelled by means of locomotive. Lifting capacity in tons shown by means of figures.

"MWU"—Wrecking Derrick. This derrick has boom and hoist fitted to frame of flat car and lifting done by means of hand power; propelled by locomotive.

"MWV"—Wrecking Derrick. This derrick has boom and hoist fitted to flat car and having drum at one end to furnish means of hoisting; steam furnished to donkey engine, running drum, by means of flexible steam line from attached locomotive; propelled by locomotive.

"MWT"—Tool and Block Car. A car used for carrying all descriptions of tool equipment and blocking. This car has side and end housings and roof, also end platforms. There are doors in sides and ends and usually windows. It is fitted inside with proper racks and boxes for storage of tools.

"MWC"—Caboose and Tool Car. Similar to tool car, but having one end fitted up as a caboose, with bunks, stove and water storage, with or without lookout, and is used in either work or wrecking trains.

"MWH"—Hand Car. This car is flat and mounted on four wheels and propelled by means of pushing, known as "Push Car."

"MWL"—Hand Car. This is a small flat car, with or without seats, mounted on four wheels and propelled by means of cranks or hand levers.

"MWG"—Section Gang or Track Inspection Car. Flat car, with or without seats or tool boxes, and equipped with single or double cylinder gasoline engine serving as motive power.

The report of the committee was not discussed and on motion it was approved and referred to letter ballot.

COUPLER AND DRAFT EQUIPMENT.

Committee:—R. N. Durborow, Chairman, G. W. Wildin, F. W. Brazier, T. H. Curtis, F. H. Stark, Thos. Roope, W. E. Symons.

The standing committee on coupler and draft equipment submitted the following report:

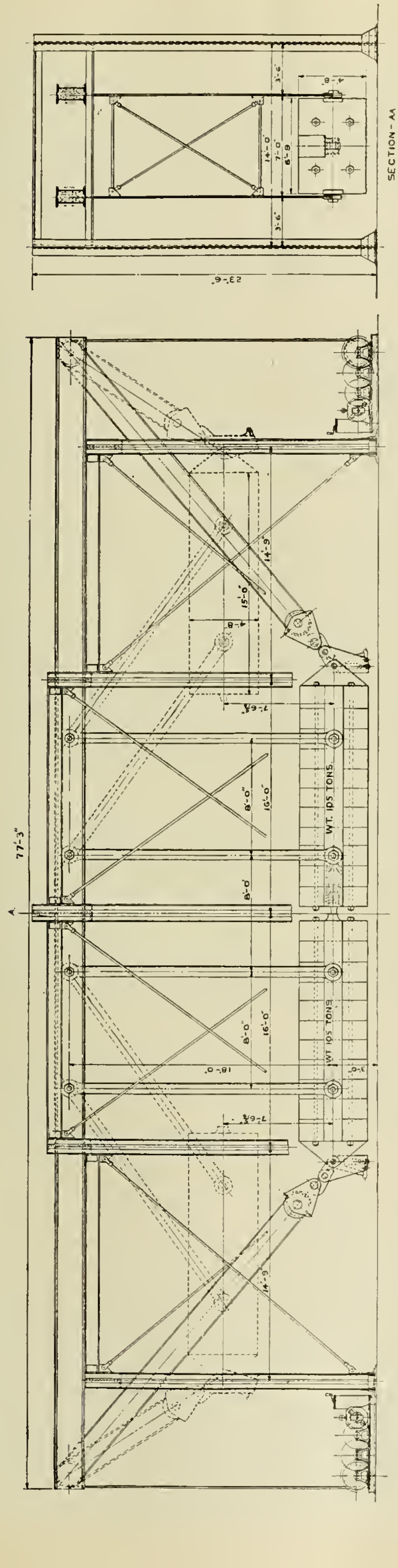
SPECIFICATIONS.

Size of Eyelet for Lock-lift Device.—In order that the text of the Standards for Automatic Couplers may agree with Sheet 23, it is necessary that the size of eyelet in locking device be added making the tenth paragraph on page 611 read, "That all couplers must have a 1 1-16-inch eyelet for unlocking device located immediately above locking pin hole."

Gauges for Knuckle Pivot Pins.—The first sentence in the third paragraph of the specifications for M. C. B. automatic couplers should be changed so as to include knuckle pivot pins, as follows: "Bars, knuckles, locking pins or blocks and knuckle pivot pins must be accurately made to gauges furnished by the manufacturer," in order to insure interchangeability.

Use of Knuckle-throwing Devices.—The requirement providing that the coupler must be equipped with an efficient knuckle-throwing device has now been a Recommended Practice for a period of five years, and nearly all of the modern couplers in use to-day are provided with some form of knuckle-throwing device. While all of the knuckle-throwing devices in use are not as efficient as the committee believes they should be, it feels that this requirement should be advanced to Standard, incorporating the following: "All couplers must be equipped with a knuckle-throwing device which will throw the knuckle completely open from any position it may assume in service." If this recommendation is adopted as Standard it should be embodied in the Standards in Section 4 of the Specifications for M. C. B. couplers after September 1, 1911, thereby giving time to the manufacturers of couplers which do not at present meet this requirement to improve their models to conform with this specification.

Lock-bearing Area.—The question of adopting a minimum allowable area of effective bearing surface between the knuckle tail and lock, and stipulating that there shall be at least as much bearing between the lock and wall of coupler, has been presented to the committee, with a view of making that minimum as large as possible, in order to insure a better distribution of pressure and consequently a less rapid wear. The commit-



MACHINE FOR TESTING FRICTION DRAFT GEARS.

tee suggests that 4 square inches be adopted as the minimum allowable area of these bearing surfaces. Of course, a larger bearing surface is desirable, but in fixing 4 square inches as a minimum at this time, the committee feels that no great hardship will be imposed upon manufacturers of existing types of couplers, and that as conditions improve this limiting area may be increased.

Twist Gauge.—The twist gauge shown on the present M. C. B. Sheet "C" should be abolished, as it has not proven useful. After an extended trial it has been found that any distortion of the coupler which this gauge would indicate could easily be detected by the eye, and, therefore, the use of the gauge was discontinued. Had this gauge proven of benefit it would have received recognition long ago by being advanced to Standard.

Shelf Brackets.—The committee desires to call the attention of the members to the fact that shelf brackets, designed to hold the uncoupling lever in a raised position, are still in use by a number of roads, on cars which are equipped with couplers conforming to the present standards. These brackets were to be abolished in accordance with the letter ballot of 1907 and, therefore, should not be allowed to remain on cars having standard couplers for the following reasons:

First: That it destroys the feature of the lock set within the head of the coupler; in other words, when the lever is locked in a raised position it must be released again by hand before coupling can be effected.

Second: The use of the inclined shelf bracket allows the rods to be locked in a raised position so that the chain is frequently taut. In case of couplers equipped with a knuckle-throwing device, when the knuckles are closed, the tail of the knuckle will strike the opener, and either bend it out of line or break the uncoupling chain. This is more pronounced in couplers where allowance is made for play of ⅜ inch behind the tail of the knuckle, as recommended in the specifications.

FRICTION DRAFT GEAR.

General Review.—The report of the committee of last year called attention to two means of obtaining definite information desired concerning the performance of draft gears, namely, by means of a series of road tests with accurate recording apparatus, and the design of a laboratory testing apparatus which will subject the draft gears to approximately the same pressures and shocks received in service.

After careful consideration, the conclusion was reached that the results to be obtained from both investigations could be combined in the latter, providing the action of the draft gears in such a laboratory testing apparatus would approximate service conditions, with the additional advantage of saving time and expense of making actual road service tests.

To make a series of service tests would necessitate equipping trains composed of cars of various types with each kind of draft gear in turn, with resulting loss of time in applying each set of draft gears during a period when there may be a great demand for cars, to say nothing of the expense involved.

The possibility of using a drop-test machine, using either the standard M. C. B. weight of 1,640 pounds or a heavier one, was considered, but the action of the draft gears under the forces of impact delivered by such a machine was found to differ greatly from their action in service, making this form of drop test undesirable.

The use of any kind of static machine would be unsatisfactory, because the load is applied slowly and does not approximate service conditions.

Draft Gear Testing Machine.—In order to place the draft gears in a laboratory testing machine so as to undergo service conditions, a machine has been designed on the principle of the double pendulum, of which the illustration shows the general arrangement.

Each pendulum weighs 210,000 pounds, which represents the probable maximum weight of a car and lading which will be encountered in service.

Provision is made for swinging each pendulum through an arc sufficient to give a maximum speed of fifteen miles per hour when at the lowest point of swing, so that with one pendulum at rest and one in motion speed up to that limit is obtainable, and with both pendulums in motion a maximum speed at the point of contact of thirty miles per hour is available.

By using the pendulums many uncertain variables are eliminated, such as the motion between trucks and car body, the shock absorbed by the truck springs, resistance offered by wheel flanges on curves, etc., which would interfere with satisfactory observation in a road service test.

The resistance offered to each blow and the force of the blows delivered at the different speeds is constant for each draft gear, making the results directly comparable.

In the illustration a draft gear is shown mounted in one pendulum, the other being simply a solid weight with a buffing surface provided at the end. The draft gear to be tested is equipped with a dummy coupler shank having a flat face which is just in contact with the buffing surface on the other pendulum, when both pendulums are hanging at rest.

The movement in either direction of both pendulums, and the movement of the coupler shank in the carrier iron, that is, the movement of the draft gear, in either direction, are to be accurately recorded by an oscillograph having a suitable time element, so that distance, velocity and acceleration at any point of swing or recoil can be determined. The records of the motions of the pendulum are obtained electrically from a contact point on each pendulum passing over a series of fixed contacts in the path of swing. The record of the motion of the draft gear is obtainable in a like manner through each ⅛ inch of travel by a contact on the dummy coupler shank passing over a series of fixed contacts in the carrier iron.

The pendulums are drawn back to the proper starting positions to give any desired speed, by motor-driven cables, fastened to the weights by hooks which can be released simultaneously by one electric key. The same key which releases these hooks starts the motion of the oscillograph.

Theoretically the difference between the sum of the travels of the pendulums from the point of release to the point of contact, and the sum of their recoils, will be a measure of the shock absorbed by the draft gear, and, therefore, of the efficiency of the draft gear. Thus, a draft gear having a low recoil would indicate a high absorption of shock and vice versa.

The pendulums are necessarily built-up weights, consisting of cast-iron segments, machined to a smooth fit, held together with tie bolts and the longitudinal framing to which the trunnions for the hangers are fastened. Provision has been made in the striking end to accommodate all the types of draft gears to be tested.

The committee regret that they have been unable to perfect the machine in time to have had a series of tests made during the past year, but expect to have the machine set up and make a series of tests of all kinds of friction draft gears now on the market, submitting a complete report at the convention of the year 1911, on the efficiency of friction draft gears.

There was no discussion of the report which was accepted and referred to letter ballot.

FREIGHT CAR TRUCKS.

Committee:—A. Stewart, Chairman; J. J. Tatum, A. S. Vogt, J. F. DeVoy and G. A. Hancock.

The subjects relating to freight car trucks, which the committee have had under consideration, are as follows:

To investigate and submit recommendations as to what changes in limits of axles are necessary to make them suitable for cars of 65,000 and 90,000 pounds capacity.

To reconcile the discrepancies existing between the measurement of the wheel seat of axle "B," on Sheet M. C. B. 7, and the condemning limits shown in Rule 23 of the Rules of Interchange.

To consider whether any revision of the present specifications for steel axles is necessary.

To consider whether any revision of the drop test for iron axles is necessary.

We are of the opinion that no intermediate sizes of axles differing from the "A," "B," "C" and "D" standards of the M. C. B. Association should be recommended. These standards have been so universally adopted in the States and Canada that it is the opinion of the committee that axles designed for the small difference in capacity suggested would only lead to confusion.

The second subject is a matter that involves discrepancies between the first and second tables under this rule, the first table having been inherited from the old rules in existence before the axles were redesigned and put in their present form. The second table under this rule, where the diameters are given in connection with maximum weights, was prepared following the method for calculating diameters of axles recommended by a committee in 1896. This was done with the idea that the practice of marking maximum weights would replace the marking by capacity, and is considered necessary for certain classes of cars, such as tank cars, etc. If the diameters given in the first table, which refer to capacity of the car, were brought up to correspond to those in the second table, it would result in a large number of the older equipment being refused at interchange points. For this reason, it is the opinion of the committee that Rule 23 should remain as at present.

Since the original specifications for steel axles were compiled and worked up, considerable data has been accumulated, not only from the service of the axles, which, as far as we can ascertain, have been exceedingly satisfactory, but by the steelmakers, who are offering data of various kinds, which indicates that a change in the composition of the steel will possibly be advisable to still further improve the axle. This refers particularly to the introduction of a higher percentage of silicon, which a few years ago was seriously objected to on account of manufacturing difficulties. However, in recent revolution tests, it appears the addition of silicon has doubled and in some cases quadrupled the life of the specimen under standard conditions of tests. This work is being continued, and probably in another year will be completed, but at present the committee is of the opinion that it would be unwise to make any change in the present axle specifications.

It seems the original committee which drew up the existing specifications for iron axles was quite aware of the fact that, so far as deflections under the drop tests were concerned, it was doubtful whether iron axles would meet the specifications, and it seems to have been its idea to discourage their manufacture. As proper wrought-iron scrap, suitable for the manufacture of axles, is becoming more and more difficult to obtain, and fewer of them are used each year, it is the opinion of the committee that no changes should be recommended in the present specifications.

There was no discussion or action on this report.

SALT-WATER DRIPPINGS FROM REFRIGERATOR CARS

Committee:—M. K. Barnum, Chairman; G. W. Lillie, W. E. Sharp, E. W. Pratt, D. C. Ross, W. C. Arp, P. Maher.

The committee made a series of tests during the hot weather of last summer, the results of which are plotted on the chart, Fig. 1 (not reproduced). These tests justify the committee in making the following recommendations:

All salt-water drippings should be retained in the ice tanks and drained off only at icing stations.

The total capacity of drain openings should not exceed the capacity of traps, and the capacity of both drains and traps should be sufficient to release all drippings within the time limit of icing the train.

The mechanism adopted for handling drain valves should be simple and positive, and so designed as to insure closing the valves before hatch plugs can be returned to their places.

Salt drippings should be conducted from ice tanks through the drain valves above described and thence to the outside of cars through the regular traps and drain pipes.

The packing companies have co-operated with the committee in their investigation, and have expressed their willingness to put into effect the practice recommended by your committee, if these recommendations meet with the approval of the Master Car Builders' Association.

In addition to the subject of "Salt-water Drippings," the Secretary of this Association has turned over to the committee correspondence from the Railroad Refrigerator Service Association, suggesting the following questions:

1. The uniform height of refrigerator cars from the rail to the floor.

2. The adoption of a standard drip cup for refrigerators.

3. Relatively small ice tanks.

The Railroad Refrigerator Service Association has not presented sufficient data to show the necessity for special action on these subjects, and the amount of information which the committee has been able to obtain indicates that any difficulties which may have been experienced from these features of refrigerator cars are due rather to old designs than to prevailing practice.

Therefore, if it is the desire of this Association to have these questions investigated, we would recommend either that a special committee be appointed for the purpose, or, if preferred, that the present Committee on Salt-water Drippings be continued for the work.

Discussion—The report was highly complimented, and Mr. Pratt reported the very gratifying co-operation of the private car owners who posses about 99 per cent. of the cars of this kind.

Action—Referred to letter ballot, committee discharged.

REPORT OF COMMITTEE ON CONSOLIDATION.

MEMBERS OF COMMITTEES.

American Railway Master Mechanics' Association.—D. F. Crawford, H. H. Vaughan, G. W. Wildin.

Master Car Builders' Association.—F. H. Clark, W. A. Nettleton, C. A. Schroyer.

Apart from any legal questions, it may be, we consider, granted that neither the Master Car Builders' nor the Master Mechanics' Association would agree to being absorbed by the other. Both have a long and honorable history. Founded in 1867 and 1868, respectively, each has accomplished magnificent results in the investigation of the multitude of problems that have arisen in the gradual development of American railway rolling stock, and in the determination of national practice in design and operation. Both are to-day progressive and successful. There is no question of either needing the assistance of the other to ensure its continuation or development. They stand as pre-eminent examples of voluntary associations of men employed by the railway companies of the country who have labored and studied for the benefit of those companies as a whole.

Such being the case, if it be decided that, for the benefit and convenience of the members of these associations, it is advisable that their work be continued by one united society in place of two separate ones, the only feasible plan would be to form a new association to take the place of the two older ones, and independently and voluntarily terminate their existence. The legal questions involved in such proceedings require investigation, and it is possible that technically some different arrangements would have to be made. This is not, however, material, and we assume that the question for discussion is not that of absorption or consolidation, but the formation of a new and united association, which, including in its members employees of both the car and locomotive departments of our railways, may be called The American Railway Mechanical Association.

A change of this kind is important and should, we believe, if carried out, be only made after the most careful consideration. There are, no doubt, however, powerful reasons in favor of such a movement; reasons which have developed from the change which has taken place in the organization of the mechanical departments of the railway companies themselves during the existence of the two associations.

The appointment of a joint official in charge of both car and locomotive departments has led to the same men being largely in charge of the design, construction and maintenance of both cars and locomotives. The consequence is that men are attending the Master Car Builders' Association in connection with car matters, and the Master Mechanics' Association in connection with locomotive matters. To a great extent, therefore, the reasons that previously existed for the maintenance of two separate associations have been gradually removed. There is, no doubt, still a considerable feeling in favor of their retention, and it was voiced very clearly by President McKenna in his address to the Master Car Builders' Association last year.*

Mr. McKenna's remarks undoubtedly require the most careful consideration. They may be regarded not only as a personal opinion, but as expressing that of a large proportion of the membership of the association over which he presided. They describe the Master Car Builders' and Master Mechanics' Association as having separate and distinct fields of action; the Master Mechanics' as being technical in its nature, while the Master Car Builders' has rather that of a legislative body. There is, no doubt, a great deal of truth in these distinctions, and yet it is questionable whether they do not refer rather to conditions existent in the past than those of to-day. The legislative nature of the Master Car Builders' Association is entirely caused by the successful action of a voluntary association in organizing the rules governing the interchange of equipment between the railway companies of the country. These rules have been so wisely drawn and fairly administered that, without any direct powers having been granted to the associations by the railway companies officially, their accedance has in practically all cases been obtained, and the Master Car Builders' Association is to-day recognized as the organization empowered to formulate regulations required to enable the transfer of cars from road to road with the greatest dispatch consistent with the respective interest of owner and user. This has been but one part, however, of the work of the Association, although it has been so well done that it has secured the admiration and endorsement of all railway managements and has led to this being regarded, perhaps, as its greatest field of usefulness. The other, and equally important, part has been that of a great technical society specializing on subjects connected with the car department and thus supplementing the work of the Master Mechanics in the locomotive field. The subjects being investigated by committees this year are, with the exception of those pertaining to the interchange of cars, just as much the work of a technical association as are those in the Master Mechanics' Association. The condition actually is that two large enginering societies are in existence: the one investigating matters connected with the design, construction and maintenance of locomotives, the other with similar subjects for cars, while the latter at the same time determines the rules governing the interchange of equipment.

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The conclusion is evident that the distinction between the work of the two associations is only in kind. It is not a distinction that necessitates the employment of different men with different training, belonging to different departments of the railways. Each is engaged in a portion of the work of the mechanical department, with the same men in charge, interested in the subjects discussed in each and bearing their share of the investigations and experiments in both.

It is difficult, therefore, to-day, to justify the continuation of two separate associations on the ground of the difference in their fields of work or the variation in their memberships. The strongest opposition to such a change is in the statement made by Mr. McKenna: "Unless improvement is possible, change should not be favored." Apart from any question of sentiment, it is a serious matter to disturb the successful operation of over forty years. The question for consideration is really whether the attendant advantages are sufficient to justify the change. The most important is the possible saving in time. Under the present arrangements, to attend the first convention means, for the majority of our members, that they must leave home on the Monday or Tuesday night, and, if they stay for the second, they cannot return until the Thursday or Friday of the succeeding week. Practically, therefore, attendance at both conventions means that two weeks must be given up to the work, and, under present conditions, this is frequently more than can be spared, important as these conventions are recognized to be.

The existence of one executive committee in place of two would reduce the demands on the time of the men enaged in carrying on the business of the associations, and would facilitate the work of selecting subjects for investigation by committees and the names of the members composing them. Under present conditions, it is practically necessary to hold the meetings of the two executive committees either jointly or in communication with each other, both for this purpose and for business connected with the carrying out of the convention arrangements. One executive committee would be more efficient in handling any matters connected with both car and locomotive departments than are two, and, if selected from various sections of the country, would form a strong and representative body for any work in which their services might be of use.

The discussion of similar subjects in two associations would be done away with. Apart from the committees on Consolidation and Arrangements, there are to-day three subjects, Safety Appliances, Lumber Specifications and Train Brake and Signal Equipment, which are being investigated by committees from both associations. In two cases the membership of the committees is practically the same, a recognition by the executive committees of the desirability of reducing as much as possible the time demanded from our members in carrying on this work. There are other subjects on which committees have been appointed on which joint action would logically be required, were it not for the recognition of the unnecessary work involved in considering the same subject in both conventions. The time has largely passed when one practice obtained in the car and another in the locomotive department unless there is a good and valid reason for the difference. The agreement on a uniform practice, if possible, or the accceptance of a reason for divergence, can be far better discussed in one association than in two, apart from the saving in the time of the members of the committees, the duplication of reports and experiments.

In a joint convention the time allotted to the various subjects could be better allotted than when the two are separate. The work in each varies from year to year, and, while, no doubt, it has a tendency to increase, there is sometimes a question whether the investigation of a subject is not carried out in order to arouse interest in the convention, rather than on account of its pressing necessity. With one executive committee the subjects could be determined on with less reference to the time at disposal and with more consideration to their relative importance. It would also be possible and advantageous to avoid the tendency to hurry the discussion on what may have proved to be a more important and contentious subject than was anticipated, which now frequently occurs in order to enable the programme to be completed on time. With double the time at their disposal, the meeting could give each subject the attention it requires, and gain on a subject which did not develop the expected discussion the additional time occupied on one which exceeded expectations.

The committee was not instructed to draw any conclusions as to the desirability or otherwise of forming a new association, and has intended to present the arguments for and against that course. It was also instructed to prepare a constitution for a new association, and considers that one modeled after that adopted by the Master Car Builders' Association last year, with certain modifications to render it applicable to a joint association, would be most suitable. It is appended.

Discussion—This subject brought out the liveliest discussion of the whole convention. A number of arguments were advanced against any consolidation of the two associations. Among these was one from Geo. L. Fowler, who thought that to combine all of the work into one week of continuous sessions would decrease the efficiency of the members at the later sessions. Mr. Schroyer mentioned the possibility of there being little time available to study the exhibits if the conventions were held within a single week.

Opposed to these ideas were Mr. Wilden, Mr. Gaines and Mr. Vaughan. The latter, as a member of the committee, presented the whole matter in a very clear-cut way, saying in part:

"The only way we can look at this matter is that the consolidation of the car and locomotive departments under one heading has already been effected on the majority of railroads. The question of the advisability of that consolidation is one that we

* See AMERICAN ENGINEER, July, 1909, page 289.

did not consider; we have to take things as they are and not as we might like them to be.

"I am not by any means prepared to advocate the advisability of the consolidation of the car and locomotive departments. I do not think that is the question at issue. The chief question is, whatever our opinions of the matter may be, that on the majority of roads the car and locomotive departments are under the charge of a mechanical officer. They are two different departments, it is true, but they are under one general superintendent. We have to admit, from the facts which exist, that a large majority of the railroad companies have felt that to be the advisable method. It seems to me that the general feeling of a railroad executive is that he wants a mechanical officer to look to for the direction of both car and locomotive matters. He has his operating man on operating matters, his accounting man on accounting matters, a chief engineer on permanent way matters, and the chief executive of a railroad wants his mechanical man on car and locomotive matters; in other words, on most of the railroads of this country a mechanical department has been organized, and the car and locomotive departments have been merged into and combined in it.

"Mr. Wildin has called your attention to the fact that we have mostly locomotive men on a great many of the committees of this association. I do not like that way of putting it. I must disagree with Mr. Wildin. I would say that the mechanical department is represented by a large number of men on the committees of the M. C. B. Association, and that a large number of the same men are on the committees of the M. M. Association. I also call your attention to the fact that your presidents and vice-presidents are men equally eligible to be officers of either the M. C. B. Association or the M. M. Association, and to a large extent the same men are interested to-day in both organizations. As Mr. Hennessey said, the car department is the department on the railroad that entails the expenditure of the most money. I do not think there are any railroads concerning which this is not true, and the consequence is that the officer in charge of the mechanical department of the railroad is practically compelled to attend the meetings of the M. C. B. Association on account of the large amount of interest he has in its meetings. He may have been a car man originally, or he may have been a locomotive man originally, through whichever line he has come up, he is obliged to take a deep interest in the convention of the M. C. B. Association because the proceedings of that association affect his road to such a vital extent.

"I cannot but feel that the tendency has been for the meetings of the M. M. Association during the past few years to suffer from the fact that mechanical officers have been called upon to attend the M. C. B. Association on account of the importance of the subjects discussed at its meetings, and also on account of the spreading out of the time occupied by these two associations. It has been a quite frequent occurrence that these men have been obliged to go home, after attending the meeting of the M. C. B. Association, and neglect the meeting of the other association.

"My feeling very keenly is that the M. M. Association is the one that needs this consolidation more than the M. C. B. Association. The M. C. B. Association has an amount of business interest to the railroads that compels the attendance of the mechanical department officers, while the M. M. Association, being more technical in its character, naturally suffers through the lack of attendance of these representatives and their failure to take the same interest in its proceedings which they take in the proceedings of the other association.

"As far as the question of time is concerned, I do not want to paint any picture of how good an association we might have, or how much time would be saved, but I do feel that one association would be stronger and would have certain advantages over two. I do not think we would be straining beyond the breaking point by attending a convention in one week, instead of spreading it over two weeks, or what practically amounts to two weeks. It seems to me, if the associations were consolidated, that the man who is chiefly interested in locomotive subjects would stroll out and have a look at the exhibits while the question of the splicing of sills was being considered in the convention. On the other hand, the car man might not be interested in the question of superheat for the locomotive, and while that subject is being discussed he would have an opportunity to look at the exhibits. I firmly believe that the attendance at the exhibits would be improved by holding the convention within the period of one week.

"It is a question in my mind as to whether the vote of the membership as a whole is constitutional, whether an amendment to the constitution would not have to be introduced to make such a vote effective. I must confess that I do not understand the legal standing of the M. C. B. Association, and I do not know that anybody else does. All these questions will have to be considered. My feeling, personally, is that Mr. Schroyer's motion is an exceedingly wise one, and it is exactly what should be done with this report—action on it should be delayed for a year to give everybody a good chance to think it over and come to some conclusion about it. It is too serious a thing to jump into without proper study. The committee never desired any such action as would bring the consolidation about rapidly. All we expected was that the matter would be carefully considered, and carried along for a year or two, so that everybody interested could have a full and unlimited opportunity to thresh it over and see whether or not such a thing was desirable.

"I believe we should add to Mr. Schroyer's motion, that the matter should be laid over for a year and, also, that it should be referred to the executive committee for further report and consideration, so that the committee may be in position to look up the legal questions concerning which, owing to a good many delays, we were unable to obtain any information. They might also look up the action that could be taken if a consolidation is deemed desirable. I think that is a matter for the executive committee to deal with. We were unable to do it on account of the delays in getting the consensus of opinion of the various members of the executive committee, and there again is an instance of the desirability of one good, strong executive committee. We took quite a lot of time in securing the consent of the executive committees of the two associations in order to procure authority to secure legal advice in the matter."

Action—The motion that the subject be laid on the table for another year, that the executive committee of the association be instructed to consider the legal and other aspects necessary to put the matter through, and that the members be given an opportunity to further consider the matter was carried.

TANK CARS.

Committee:—A. W. Gibbs, Chairman; C. M. Bloxham, S. K. Dickerson, J. W. Fogg.

In the report of the committee to the last convention, attention was directed to tank cars constructed without side sills, on which no means are provided for jacking to facilitate handling in derailment and repairs.

In order to determine the necessity for these jacking castings, tests were made with a loaded tank car, limit weight 132,000 pounds, fitted with continuous center sills, but no side sills, and not equipped with jacking castings; also with a loaded tank car, limit weight 132,000 pounds, constructed with reinforced shell, having no center sills or side sills, and not equipped with jacking castings.

In addition to these tests made by the committee as a whole, the individual members of the committee looked into the matter at their home shops, and, while they found comparatively few cases where it was necessary to jack loaded cars, not equipped with side sills, for the removal of wheels and still a lesser number for the removal of trucks, the consensus of opinion is that jacking castings are desirable to promote safety in doing the work, aside from the question of additional labor involved when these cars are not equipped with suitable jacking castings. The most suitable location would seem to be at the body bolster.

Inasmuch as there are freight cars of other types in service which should also be provided with suitable jacking castings, on account of the present difficulty experienced in jacking up cars not equipped with side sills of sufficient section to withstand the pressure of the head of the jack, this question becomes one of general importance, and the committee would, therefore, recommend that a special committee be appointed to go into this question generally, so that any Recommended Practice adopted will cover the whole situation.

With this question eliminated, the work of the Tank Car Committee is practically concluded, and, as the provisions of the Tank Car Requirements have now been Recommended Practice for a number of years, the committee would recommend that the present Recommended Practice be advanced to Standard and the committee discharged.

Inasmuch as the various railroads are now printing their own tank-car circulars, we think it would be advisable for the M. C. B. Association to have them printed in pamphlet form, so that they can be purchased by the various members at a nominal sum, the same as the Interchange Rules and the Loading Rules.

It was voted to submit the present recommended practice for tank cars to letter ballot for adoption as a standard.

TRAIN BRAKE AND SIGNAL EQUIPMENT.

I.—LAKE SHORE EMERGENCY BRAKE TESTS.

Committee:—A. J. Cota, Chairman, F. H. Scheffer, R. K. Reading, E. W. Pratt, R. B. Kendig, T. L. Burton, B. P. Flory.

Representatives from several railroad companies having under construction heavy steel passenger equipment cars proposed to the executive committee of this Association, during its convention last year, a subject requiring the immediate consideration of the Committee on Train Brake and Train Signal Equipment, namely, *The definition of proper air-brake equipment for passenger cars weighing 130,000 pounds or over."*

The Committee on Train Brakes and Signal Equipment was accordingly summoned to attend a joint meeting of the committee and representatives from various railroad companies and manufacturers directly interested in the subject, at the Union Station, Pittsburg, July 1, 1909.

There were present at this meeting representatives from the Pennsylvania Railroad System, New York Central Lines, Baltimore & Ohio Railroad, Pullman Company, American Brake Shoe & Foundry Company, American Brake Company and Westinghouse Air Brake Company. Other brake manufacturers were requested to have representatives present, but failed to do so.

A. W. Gibbs, G. S. M. P., Penna. R. R. Co., was elected chairman of the meeting. The object of the meeting was, on the request of the chairman, explained by Mr. A. L. Humphrey, in effect that some hundreds of passenger cars contracted for early delivery would be of such weight as to have practically outgrown the foundation brake rigging of to-day, and a radically new design was imperative. However, it would be too late for consideration after the next Master Car Builders' convention. The heavy cars contracted for would soon be delivered and brake designs must be decided upon at once. It was further brought out that until five years ago the maximum weight of cars approximated 90,000 to 110,000 pounds, and with such cars it was found necessary to employ 16-inch or 18-inch brake cylinders. The leverage ratio used was as high as 9 to 1, which is the recognized maximum ratio of leverage permissible; the 18-inch cylinder would provide for cars of maximum weight up to 127,000 pounds. For cars above this weight it will be necessary to increase either the leverage ratio or the cylinder power. Cars now under construction will weigh from 140,000 to 150,000 pounds and even more, which makes it necessary to redesign foundation brake rigging so as to provide a suitable brake.

Manufacturers could probably meet the conditions by employing a 20-inch brake cylinder. This, however, is very objectionable from many standpoints. It would involve the question of clearance space underneath the car, severe horizontal stresses in car body members, increased cylinder leakage, it being quite impossible to obtain packing leathers of sufficient uniformity to prevent excessive leakage, and the pistons, rods and lever would become so heavy that it would require some fifteen or twenty per cent. of the brake power to move them. It was felt, therefore, that the 20-inch brake cylinder is impracticable.

If not a 20-inch cylinder, it would necessarily call for two cylinders of an approximate equal area, say two 14-inch cylinders, one on each end of car. This would mean a complication in the way of double equipments, which should receive careful consideration on the part of the Master Car Builders' committee and railroad representatives present. It would also be quite difficult to operate the two equipments with one triple valve.

Another proposition would be to place the entire apparatus on the trucks, using either a single or two cylinders of equal area, which method, if considered desirable, would require flexible connection between the brake pipe and the cylinders.

Another method would be to use the clasp brake, requiring two brake beams or four shoes to each pair of wheels. There are, however, many objections to this design also, and it is very questionable whether the acknowledged theoretical advantages of the clasp brake would be considered practicable.

Another scheme would be to permit an increase of piston travel by lengthening the brake cylinder. This is also objectionable on account of the undesirable angularity of levers thus involved.

The matter can, therefore, be resolved into five propositions, as follows:

1. A 20-inch diameter brake cylinder, with increased packing leakage.
2. Two brake cylinders per car, which would probably make it necessary to provide two complete brake equipments, including triple valves, etc., whether applied to the car body or trucks.
3. Clasp brakes, meaning the application of two brake shoes per wheel, one on either side. This method would probably provide ample braking power for a 150,000-pound car using an 18-inch diameter brake cylinder, with a leverage ratio of 9 to 1.
4. Increased length of an 18-inch brake cylinder, and consequent longer piston travel, with an increased leverage ratio and objectionable angularity of levers.
5. Two brake cylinders of equivalent area to one 20-inch cylinder applied one to each truck.

Further discussion of the subject proved it to be a quite live one. The demands for heavy high-speed passenger service have developed a class of equipment, whether of steel or of composite steel and wood construction, whose requirements demand unit weights of cars far in excess of that required even five years ago.

The brake apparatus has not kept pace with the increased weights and speed of the modern passenger train. Contributing factors which make necessary a different treatment in the application of braking or retarding force than that heretofore practiced are, briefly:

1. Increased unbraked locomotive weight.
2. Increased train momentum.
3. Increased brake rigging deflection and false motion, due to severe stresses in car members and other causes, which greatly increase the piston travel.
4. Increased brake leverage ratio, with consequent increased piston travel and lower maximum cylinder pressure.
5. Increased time to obtain brake effectiveness, on account of large cylinder volumes.
6. Decreased brake shoe coefficient of friction, due to greater brake shoe pressures and speeds.
7. Possible breaking down of the brake shoe under the severe conditions imposed.

It was the sense of the meeting that the problem should at once be considered from both a practicable and theoretical standpoint, and accordingly a sub-committee, composed of Mr. A. J. Cota, T. L. Burton and D. F. Crawford, was appointed, to determine the scope of and establish a basis for the investigation. The following resolutions, as submitted by this committee, were unanimously adopted by vote of the railroad representatives present:

"*Resolved*, That it is the sense of this meeting that the air brakes provided for the heavier passenger cars now building shall be of such design, proportion and capacity as to enable trains of the said heavier passenger cars to be stopped in practically the same distance after the brakes are applied as is now the case with existing lighter cars; and be it further

"*Resolved*, That for the use of this committee and others interested in making calculations, we suggest that it be assumed that the theoretically desirable stop is one which required the space of not over 1,200 feet after the brakes are applied, the speed of the trains at the time of the application of the brakes being sixty miles per hour."

Another sub-committee was then appointed, composed of Messrs. W. F. Keisel, Jr., R. B. Kendig, C. S. Knapp, W. V. Turner and F. W. Sargent, to make recommendation as to the maximum load per brake shoe, from which figure would be calculated the percentage of retardation necessary and also to make recommendations as to the number of shoes per car for different weight of cars.

The sub-committee was continued for a meeting of the representative committee, at which time they were to report on the following questions:

1. Allowable pressure per shoe.
2. Arrangement of cylinders and number of shoes for eight-wheel cars weighing 90,000 pounds and over.
3. Arrangement of cylinders and number of shoes for twelve-wheel cars weighing 120,000 pounds and over.
4. Recommendations as to limit of capacity and deflection of brake beams where used on above cars.
5. Recommendations as to arrangement of hand brakes.

A brief synopsis of their report follows:

1. F. W. Sargent, chief engineer of the American Brake Shoe & Foundry Company, assisted by R. C. Augur, then of the Westinghouse Air Brake Company, made a number of tests at the former company's laboratory, Mahwah, N. J., for the purpose of determining the mean coefficient of friction between wheel and shoe with M. C. B. Standard dimensions for plain and chilled cast-iron shoes. The results of the tests indicated that the mean coefficient of friction as high as 10 per cent. could probably be realized in service.

Based on these tests, it was the opinion of the committee that the maximum pressure per shoe should be set at 18,000 pounds, or 400 pounds per square inch, and that in no case should these pressures be exceeded.

2. It was agreed that the stop distance should be measured from the point where brake application is made, and that allowance would, therefore, have to be made in the calculations by deduction from the length of stop for the lapsed time before the brake became effective, estimated at two seconds, or a traveled distance of 176 feet, at the initial speed of sixty miles per hour.

3. In order to determine a basis on which to consider the brake power of the cars themselves, an ideal train, consisting of one locomotive and six cars was selected. It was agreed that the total weight of cars in the ideal train should be considered as being twice the weight of locomotive and tender. In other words, the weight of locomotive and tender should be one-third the weight of the entire train. Previous tests seemed to indicate that the effectiveness of brake on locomotive and tender is decidedly less than on cars. In some previous tests, when engine was disconnected immediately before brake application, the distance in which the locomotive came to a stop was nearly twice the distance in which cars stopped. It was decided, therefore, to class the effectiveness of locomotive and tender brake at one-half that of the cars. Taking the car effectiveness at 100 per cent. and the locomotive at 50 per cent., and assuming the train composed of three unit weights, the brake effect of the ideal train would be in the ratio of 250 to 300, or as 5 to 6, as compared with the 100 per cent. effectiveness of the cars. It was assumed, therefore, that a greater car retarding force would be necessary in the proportion of 6 to 5 than that necessary to stop the cars alone in that distance.

4. A further increase in the retarding factor for the cars is required to compensate for the load on cars, which was estimated as 7 per cent. of the light weight of train. It was thought advisable to apportion this load over the train as follows:

Sleeping cars, 3 per cent. of light weight of cars.
Coaches, 10 per cent. of light weight of cars.
Load cars, 15 per cent. of light weight of cars.

5. With the foregoing data and assumptions determined, the required retarding force in terms of weight of car could be found as follows:

F = retarding force.
s = desired length of stop in feet.
w = weight of car.
V = velocity in feet per second.

(1) $S = \frac{5(s - 2V)}{6}$ = compensated length of stop in feet, allowing for elapsed time to brake effectiveness, and also for the effect of the unbraked weight of locomotive.

l = lading allowance to be added to w,
.03w for sleeping cars,
.10w for coaches,
.15w for load cars.

(2) $W = w + l$.

g = acceleration of gravity = 32.2.

Then for the work to be done,

(3) $FS = \text{work} = \frac{1}{2}MV^2$, and where $M = \frac{W}{g}$

(4) $F = \frac{W\ V^2}{2\ g\ S}$

6. The coefficient of friction of the brake shoe against wheel was decided as 10 per cent. The efficiency of the brake rigging was assumed from previous tests to be 85 per cent.

For cars equipped with brake beams the ratio of maximum cylinder pressure to maximum shoe pressure should not exceed 9; for cars without brake beams this ratio should not exceed 9.63; the maximum shoe pressure to be 18,000 pounds, as previously stated.

Based on these figures, the maximum car weight for single shoe per wheel could be determined from the formula.

If brake beam release springs or other devices materially affecting the efficiency of the brake gear are used, suitable allowance should be made.

7. It was recommended that brake beams used on these cars should not deflect more than 1-16 inch under maximum emergency brake load, and that such brake beam should not take a permanent set under a load of 50 per cent. in excess of the emergency brake load.

8. It was recommended that the hand brakes should be so connected that neither the cylinder nor hand-brake rod should act as a fulcrum for the other; also that the slack adjuster should be so located that it adjusts both air brake and hand brake equally; that there should be room for at least 30 inches, preferably 36 inches, of chain on each shaft, or worm, of the winding apparatus, with 3,000 pounds pull on the hand-brake rod; that a release spring should be attached to the hand-brake lever to release the hand brake and prevent excessive sagging of the chain; that cars which are equipped with two cylinders have the hand brakes at the two ends of car arrranged to operate independently of each other, and that each should apply the brake on one truck only.

With two cylinders per car, both cylinders should be attached to car body.

9. As there seems to be a possibility of pushing the axle out of its bearing, on account of high brake power, this question was taken into consideration. The committee recommended that the resultant of static load and brake-shoe pressure on axle be determined, and that the direction of this resultant be kept inside of a line through center of axle and edge of bearing to an amount equal to 10 degrees. Other forces also act at this point, such as brake hanger effect on truck frame and friction between journal and bearing. If careful estimate of direction of resultants, based on all forces acting on the journal, is made, it would seem sufficient to have the direction of this resultant, when passing through center of axle, 5 degrees inside of the line throught center of axle and edge of bearing. The direction of the resultant may be varied by lowering the brake shoe. It was further considered that, on account of the high brake effect on passenger cars, the strain on the axle would be greater than on the same axle in freight service. The minimum resultant of static load, and brake pressure in freight cars, had been estimated at 125 per cent. of static load. For passenger cars the minimum resultant was estimated at 187.5 per cent. of static load, or 50 per cent. greater than in freight service. Passenger cars, however, have a lower center of gravity than that taken for freight cars, which has a tendency to reduce the strain per journal. Axles are also less subject to shock in passenger service than in freight service, for which reason it did not seem necessary to make an allowance commensurate with this condition. This indicated that it was not advisable to make an arbitrary reduction in axle capacity under static load for passenger service, without a more careful investigation than possible in the limited time at command. Since the axle capacity is not a function of the brake design, this subject can be held in abeyance until the various railroads can look into the question fully and give their recommendations.

Discussion following the reading of report resulted in a consensus of opinion that before acceptance of the recommendations offered a demonstration should be made by actual road tests with trains such as considered, during which tests records should be taken of all items of interest and particularly those representing the basis for calculating lengths of stop.

The programme decided upon for the trials contemplated the following comparisons:

1ST—TRAIN CONSISTS.

a. Two locomotives and ten twelve-wheel cars.
b. One locomotive and ten twelve-wheel cars.
c. Two locomotives and six twelve-wheel cars.
d. One locomotive and six twelve-wheel cars.
e. One locomotive and six eight-wheel cars.

Dynamometer car to be used in several runs to measure the unbraked locomotive effect.

2D—SPEEDS.

a. Sixty miles per hour.
b. Eighty miles per hour.

3D—BRAKE EQUIPMENT.

Twelve-wheel Cars.

a. High-speed brake, 90 per cent. of weight of car, based on 60 pounds cylinder pressure. With maximum cylinder pressure, 85 pounds equals 127.5 per cent.

b. Retarding percentages as recommended by committee, with cylinder pressure 105 pounds. Note that, as explained in committee's report, this force varies for different classes of cars.

Eight-wheel Cars.

c. High-speed brake, 80 per cent. of weight of car, based on 60 pounds cylinder pressure. With maximum 85 pounds cylinder pressure equals 113.3 per cent.

d. The same brake leverage at 105 pounds cylinder pressure, which is equivalent to 140 per cent. braking power.

4TH—BRAKE SHOES.

a. Chilled cast-iron shoes.
b. Plain cast-iron shoes.
c. Experimental, or even proprietary brake shoes, if necessary, on account of the possible breaking down of the cast-iron shoes under the enormous test pressures proposed.

The American Brake Shoe & Foundry Company offered to furnish the necessary brake shoes required for the tests, which offer was also accepted.

The brake shoes requested for test were as follows:

1. Plain cast-iron, to P. R. R. specification.
2. Chilled end cast iron, commonly known as the "U" shoe, as used on the New York Central Lines.
3. Chillled inset cast iron, Streeter type, as commonly used on a number of roads.
4. Composite steel and cast iron, commonly known as Diamond S, also used by a number of railroads.

The above types of brake shoes were considered as fairly representing the types commonly used in passenger service throughout the country. In addition, the brake shoe company was requested to furnish another type, if possible, having a greater mean coefficient of friction, considering the service, than those mentioned above; this type was not named, and will be classed simply as "Experimental."

A stretch of ground, with stopping ground, two miles west of Milbury Junction, on the main line of the Lake Shore & Michigan Southern Railway, was selected for the test. This selection was made with the idea of obtaining a perfectly level stopping ground at a point on the road where the passenger train schedule permitted the use of a high-speed testing track for considerable time during the day, without interfering with the regular passenger traffic. There are four tracks between Milbury and Toledo, which permitted the freight movement, uninterrupted, on the outside tracks.

An old box-car body was set off at the stopping ground and fitted up as a cabin, in which were installed the chronograph outfit for recording the succcessive speeds of train during the stop, telegraph instruments for following the movement of the test train, telephone for communication along the test ground, and drawing-tables, at which were worked up daily, for distribution to members of the crew and visitors, a complete log, showing the results of the runs made the previous day.

Circuit-breakers arrranged to record the movement of the test train were located along the track at equal intervals in electric communication with the chronograph. This enabled the speed of train over each 100-foot interval, after passing the trip, to be recorded. The trip consisted of a wedge-shaped obstruction outside the rail, which engaged a mechanism on the locomotive operating a cut-out cock, which in turn made an emergency application of the brake the instant the locomotive passed the trip. Circuit-breakers were also located back of the trip some distance, from which the speed at time of applying the brake could be accurately determined. A more complete description of the testing apparatus is given in the appendix (not reproduced).

The twelve-wheel cars (L. S. & M. S.) used in the test were equipped with the original foundation brake and apparatus as received from the car builders, being at that time the New York Central Lines' standard practice for that class of equipment. The apparatus was of the improved type, with supplementary reservoir to give 105 pounds emergency brake cylinder pressure at 110 pounds brake-pipe pressure, and for want of simpler description will be designated by the manufacturers' symbol, LN. The cylinder levers were changed to conform with the committee's recommendation for retardation at brake shoe. Additional apparatus was installed on each car, so that quick change could be made to the high-speed brake practice for comparison.

The normal weight of the car was approximately 126,000 pounds, and under the conditions laid down by the sub-committee this would not give the maximum permissible brake-shoe pressure. A pressure of 18,000 pounds per brake shoe was provided for, however, by loading one of the cars to 149,000 pounds; another was loaded to 140,000 pounds, as an intermediate step, and the remaining cars tested at normal weight.

The application of such force as 18,000 pounds to a brake shoe involved the design of a special brake beam, which was undertaken by a Cleveland concern, but in the limited time available only a sufficient number were secured to equip the two heavy cars; the remaining cars were equipped with the regular high-speed brake beams of the same general design, which was of the trussed type, having an angle-iron compressing member and round-bar tension member. The special brake beam tested at 49,000 pounds with 1-16-inch deflection, as against 30,000 pounds for the beams used on the normal weight cars. It appears, therefore, entirely feasible to obtain brake beams which will meet the specification requirement contained in the sub-committee report.

The eight-wheel cars used in the test were equipped for high-speed brake, but additional apparatus was supplied to make a quick change to 105 pounds brake cylinder pressure, using the same brake leverage. The normal weight of these cars was 116,000 pounds, some 10,000 pounds heavier than the allowable weight recommended by the committee; for eight-wheel cars one shoe per wheel, so that the recommended retarding force could not be applied without exceeding the proposed limit of brake-shoe pressure.

It is regretted that on account of the unfavorable track conditions approaching the testing ground (a slightly ascending grade, with a bad curve two miles east of the trip) a speed of eighty miles per hour was not attained. Runs above sixty miles per hour were made at maximum speed of the locomotive instead of the programme speed.

The test was started on October 19 and continued until December 12, 1909, during which time two hundred and fifty-four (254) runs were made, each and every one of which is recorded in the test log (8 sheets) which accompanies this report.

Mr. S. W. Dudley, assisted by Mr. A. H. Elliott and other engineers under the direction of the committee, made a most thorough study and analysis of the data obtained from the tests, and their report is submitted as an appendix to this report, for the benefit of those who wish to make a detail study of the results.

A meeting of the sub-committee was held to consider the results of the test as applying the assumptions on which their recommendations were based, and after reviewing the data as analyzed in the appendix to this report, the following modifications to their recommendations were agreed upon.

1. Allowable brake-shoe pressures recommended as 18,000 pounds per square inch. The result of the test seemed to indicate that under the test conditions a pressure of 18,000 pounds per shoe can be safely used, and this maximum shoe pressure will stand as originally recommended. Pressures as high as 26,000 pounds total, or over 500 pounds per square inch, were used at sixty miles per hour with all the brake shoes tested, with no apparent bad results, but when the stop was made at higher speeds it was noted that the plain cast-iron shoes would heat to a high degree, emitting molten metal, which deposited on the track, car trucks and body. The only positive indications, however, that the danger point had been reached was on run No. 328, Penna. cars with 20,700 pounds total, or 449 pounds per square inch, brake-shoe pressure, plain cast-iron shoes, speed 74.75 miles per hour. On this stop a veritable flame of molten metal from 12 to 18 inches long was emitted from each of the shoes, and a number of them were heated to a red heat in making this stop.

2. Brake cylinder leverage ratio recommended, 9 to 1. The results of the test seemed to indicate the ratio to be too high. On the L. S. & M. S. six-wheel truck cars the increase of running emergency piston travel over standing emergency piston travel was very noticeable, amounting to as much as 4 or 5 inches. The brake shoes are of necessity hung low on six-wheel trucks and the high braking power was sufficient to drag the shoes downward, imposing a force on the brake hangers sufficient to compress the equalizer springs solid. With 6-inch standing emergency piston travel there would be danger of the piston bottoming in the brake cylinders, especially after the cars had been in service some time, with boxes, pedestals, etc., worn sufficiently to produce additional false piston travel over that obtained in the tests. Car 824 was equipped with two cylinders, giving a cylinder leverage ratio of 5 to 1, and from a study of the performance of this car it is concluded that for this class of car, with brake-shoe centers at least 6 inches below center of wheel, a ratio of 6 to 1 should not be exceeded.

The Penna. R. R. four-wheel truck cars had brake shoes hung 1½ inches below the center line of wheel, and noting from the performance of these cars the lever ratio should not exceed 8 to 1. The recommendations would then stand:

Cars having brake shoes hung 0 to 2 inches below center line of wheel, lever ratio 8 to 1; 2 inches to 5 inches below, 7 to 1, and below 5 inches, 6 to 1.

3. Time from brake application to brake effectiveness assumed by the committee as two seconds. In explanation, this term was based on the retarding effect produced after full cylinder pressure is obtained, and is the lapsed time when, if the average force had been instantly applied, would produce the same effect. It will be noted that every second of time taken from this term would have the effect of actually shortening the stop by a distance corresponding to the velocity in feet per second at the time when brake valve was operated in emergency application. As previously stated, the brake apparatus available at the time of equipping the test trains was 18-inch cylinders on all cars.

(A) Westinghouse LN equipment, designed to obtain in emergency, by means of a supplementary reservoir, a brake-cylinder pressure of 100 pounds at 8-inch piston travel with 110 pounds brake-pipe pressure.

(B) Westinghouse high-speed brake equipment, designed to give with 8-inch travel and 110 pounds brake-pipe pressure a maximum pressure of 80 pounds, which gradually blows down to 60 pounds toward the end of stop.

The test indicated that with the LN equipment the lapsed time was 2½ seconds, and with the high-speed equipment 2¾ seconds. On account of excessive running emergency piston travel, however, but 95 pounds cylinder pressure was obtained with the LN equipment, instead of the 100 pounds expected. In order to obtain 105 pounds cylinder pressure with this equipment it was necessary to increase the brake-pipe pressure above 110 pounds.

Another triple valve was substituted for the LN triple valve, known as the LGN, with which it was expected to obtain 105 pounds emergency cylinder pressure with 110 pounds train-pipe pressure. This equipment used the same auxiliary reservoir and supplementary reservoir as the LN equipment, but obtained its higher pressure by first equalizing with the auxiliary reservoir, then closing the communication between cylinder and auxiliary reservoir and further equalizing with the supplementary reservoir. This equipment was deficient as to pressure obtained by about two pounds, on account of the long running emergency piston travel experienced. While the test was continued by increasing the brake-pipe pressure to give 105 pounds emergency cylinder pressure, under these conditions it could not be expected with 110 pounds brake-pipe pressure to make quite the same stop as in these tests. The lapsed time to brake effectiveness was the same with this equipment as with the LN—2½ seconds. It became evident at this stage of the trials that unless the time from brake application to effectiveness could be shortened there would be small likelihood of making the stop in the desired distance of 1,200 feet.

In order to meet this condition the Westinghouse Air Brake Company undertook the design of an equipment which dispenses with the use of triple valves, using instead a valve of the general type of the distributing valve called a control valve. With this equipment larger pipes and ports between the air reservoirs and the brake cylinders can be used, thus materially shortening the time of obtaining maximum cylinder pressure. In the limited time available during the test they were able to design, build and install on the test train a complete experimental equipment of the type mentioned, and with this equipment the lapsed time between brake application to effectiveness was reduced to two seconds, which answered the requirements of the sub-committee, and with this equipment the desired stop was actually made.

4. Ratio of train weight to locomotive weight assumed by committee as 3 to 1. The six-car L. S. & M. S. train had a weight ratio train to locomotive, 3.04 to 1, and the P. R. R. train ratio to locomotive was 2.8 to 1. It is seen, therefore, that the previous assumption of the committee represented fair average train conditions and will stand as first recommended.

4-A. Relative effectiveness of locomotive brake to car brakes assumed by committee as 50 per cent. These tests indicate a much greater relative effectiveness of the locomotive brake which, as shown by the results of break-away runs, where the improved type of locomotive and car brakes were used, should be increased to 75 per cent., and that figure is now recommended.

4-B. Ratio of train to car-brake efficiency derived from previous assumption of committee by combining assumptions in paragraphs 4 and 4-A, which was originally 5-6. Combining the revised factors, paragraphs 4 and 4-A, a factor 11-12 is derived.

5. Efficiency of brake gear assumed by committee as 85 per cent. of the cylinder effect.

5-A. Coefficient of friction assumed by committee as 10 per cent.

5-B. The apparatus which the committee had available to determine the brake-gear efficiency was not of sufficient capacity to obtain satisfactory results with the heavy cars used in the test. Neither was apparatus available to determine the coefficient of friction. It was therefore necessary to combine these two factors by taking their product. With the committee's previous recommendations this factor is 85 per cent. times 10 per cent., or 8.5 per cent. From the data of the break-away tests with the improved equipment, it appears that not more than 7.5 per cent. was realized. This factor should, therefore, be changed accordingly.

6. Concerning the additional retarding force to compensate for loads as previously recommended—3 per cent. for sleeping-cars, 10 per cent. for coaches and 15 per cent. for load cars—it was thought advisable to modify this somewhat, to avoid complications in the maintenance of brake gear. The new recommendation would be to make no load allowance for sleeping-cars, coaches and other strictly passenger-carrying cars, except that the recommended retarding force would be considered as a minimum. For load cars an allowance of 15 per cent. additional retarding force is recommended, which is considered as the maximum.

Returning to the formulæ for retardation, the new assumptions make the following changes:

$$S = \frac{11(S-2V)}{12} \text{ instead of } 5\text{-}6\ (S-2V).$$

$l = 0$ for passenger-carrying cars.

$l = 15$ per cent. for load cars.

Then by the substitution of known values in equation (4), the revised retarding force becomes

$F = 12.8$ per cent. for passenger cars.

$F = 14.7$ per cent. for load cars.

One of the most interesting and instructive, if not the most important results of the test, was the determination, by means of the dynamometer car, of the loss in tractive effort due to brake shoes rubbing the wheels.

The ten-car, twelve-wheel car train, with dynamometer car between locomotive and cars with brake adjusted at 6-inch standing emergency piston travel, required a drawbar pull of 8,370 pounds at sixty miles per hour, and on the next run same train, but with brakes adjusted at 7-inch standing emergency piston travel and brake shoes pried free of the wheels, the drawbar pull was only 6,200 pounds at the identical speed, indicating a loss of 35 per cent. tractive effort on the train with brake shoes rubbing the wheels. These forces were the average forces apportioned to speed over one mile of the run, obtained by subtracting the calculated uniform accelerating force from the observed average dynamometer pull in each case, and this accelerating force was so small and practically uniform in both cases as to be negligible. The 6-inch piston travel in emergency would probably amount to 7-inch, or the maximum allowable, in service, so that on trains with heavy cars equipped with six-wheel trucks and a 9 to 1 and greater brake-leverage ratio, this loss is going on, day after day, on all our heavy, fast passenger trains. The recommendation of a 6 to 1 leverage, therefore, should be given consideration as the most rational method of correcting this great loss in tractive effort and corresponding waste of fuel. There are hundreds of cars running to-day wherein this saving can be effected and advantage of this knowledge should be taken.

From the revised assumption for cylinder leverage and brake-shoe coefficient of friction times brake efficiency, a new table follows, which gives the size of cylinders recommended by, the committee for various weight cars above 100,000 lbs. and cylinder pressure 85 pounds per square inch.

PASSENGER-CARRYING CARS.

One brake shoe per wheel.

Brake shoes hung 5 inches and more below wheel centers.

Brake leverage, 6 to 1.

Two 16-inch cylinders, cars weighing 100,000 to 121,000 lbs.
Two 18-inch cylinders, cars weighing 121,000 to 154,000 lbs.

Brake shoes hung 2 to 5 inches below wheel centers.

Brake leverage, 7 to 1.

Two 18-inch cylinders, cars weighing 142,000 to 180,000 lbs.
Two 16-inch cylinders, cars weighing 109,000 to 142,000 lbs.
Two 14-inch cylinders, cars weighing 100,000 to 109,000 lbs.

Brake shoes hung 0 to 2 inches below wheel centers.

Brake leverage, 8 to 1.

Two 18-inch cylinders, cars weighing 162,000 to 205,000 lbs.
Two 16-inch cylinders, cars weighing 124,000 to 162,000 lbs.
Two 14-inch cylinders, cars weighing 100,000 to 124,000 lbs.

Limit of passenger-carrying cars, one shoe per wheel.

12-wheel cars ....149,000 lbs.
8-wheel cars ....100,000 lbs.

LOAD CARS.

One shoe per wheel.

Brake shoes hung 5 inches and more below wheel center.

Brake leverage, 6 to 1.

Two 18-inch cylinders, cars weighing 106,000 to 134,000 lbs.
Two 16-inch cylinders, cars weighing 100,000 to 106,000 lbs.

Brake shoes hung 2 to 5 inches below wheel centers.

Brake leverage, 7 to 1.

Two 18-inch cylinders, cars weighing 123,000 to 156,000 lbs.
Two 16-inch cylinders, cars weighing 100,000 to 123,000 lbs.

Brake shoes hung 0 to 2 inches below wheel centers.

Brake leverage, 8 to 1.

Two 18-inch cylinders, cars weighing 141,000 to 178,000 lbs.
Two 16-inch cylinders, cars weighing 108,000 to 141,000 lbs.
Two 14-inch cylinders, cars weighing 100,000 to 108,000 lbs.

Limit of load cars, one shoe per wheel.

12-wheel cars ....129,000 lbs.
8-wheel cars .... 86,000 lbs.

Undoubtedly more consideration will be given to the clasp brake (with two shoes per wheel) both on account of its reducing the number and size of cylinders, but also lessening the dimensions and weight of brake rigging.

II.—TESTS OF TRIPLE VALVES MADE BY MASTER CAR BUILDERS' COMMITTEE ON TRAIN BRAKE AND SIGNAL EQUIPMENT.

[Results from tests made at Purdue University on two new triple valves were given in the report but the committee did not feel that sufficient data had been obtained to justify it in recommending to the convention a new code of tests for triple valves.—Ed.]

Discussion—It was explained that the committee had no recommendation to make in connection with flanged shoes. Mr. Burton personally considered that there was no question but what the flange shoe materially increases the efficiency of the brake.

Mr. Devoy thought we were trying to stop the very heavy modern trains in too short a distance.

The committee was continued.

[*Reports of committees with discussion and action thereon covering the following subjects will be given in the next issue: —Car wheels, train lighting and equipment, mounting pressures for various wheels and axles, train pipe and connection for steam heat, lumber specifications, splicing underframes, car framing, roofs and doors, brake shoes, design of axle to carry* 50,000 *lbs.* —Ed.]

Inverted Pintsch Mantle Lamp.—Over 73,000 lamps, using inverted mantles, have been placed on cars since October 1, 1909, bringing the lamps in service up to the tremendous totals of 60,000 in North America; 69,000 in England; 101,000 in France; 202,000 in Germany, etc.

Officers of the General Foremen's Association.—C. H. Voges, C. C. C. & St. L., Bellefontaine, Ohio, Pres.; T. F. Griffin, C. C. C. & St. L., Indianapolis, Ind., first vice-president; J. A. Boyden, Erie, at Cleveland, Ohio, second vice-president; E. A. Murray, master mechanic of the C. & O., Lexington, Ky., third vice-president; H. D. Kelley, C. & N. W., Chicago, fourth vice-president; L. H. Bryan, D. & I. R., Two Harbors, Minn., secretary-treasurer. The following were elected members of the executive committee in addition to T. J. Finerty, International & Great Northern, and L. H. Bryan, D. & I. R., whose terms have not yet expired: E. F. Fay, Union Pacific, Cheyenne, Wyo.; F. C. Pickard, master mechanic, C., H. & D., Indianapolis, Ind.; Wm. Hall, C. & N. W., Escanaba, Mich.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

FORTY-THIRD ANNUAL CONVENTION.

ABSTRACT OF COMMITTEE REPORTS AND PROCEEDINGS OF THE CONVENTION.

The convention was opened on Young's Million Dollar Pier, Atlantic City, N. J., on June 20, by the president, Geo. W. Wildin, superintendent motive power N. Y., N. H. & H. R. R.

After the opening prayer, address of welcome from Mayor Stoy and reply by Eugene Chamberlain, the president delivered his address. He extended the thanks of the association to the Hotel Men's Association for their many kindnesses and also to the Supply Manufacturers' Association for the exhibit, etc. In this connection he expressed the appreciation of railroad men in general for the work of the Railway Business Association.

Following this the president advanced a new idea, as follows:

"There comes a time in the history of all organizations when important changes must be inaugurated both in the method of conducting business and in the scope and magnitude of the work to be covered. I feel at this time that as an association we have about reached that point. It is hoped, therefore, that you will pardon my seeming presumption if I enter upon a mild criticism of our usual methods and customs. In doing this, however, I wish it to be most clearly understood that far be it from my intention, and much less my desire, to detract one jolt or tittle from our past achievements. Disloyalty only would brand the man who as presiding officer of this association would wantonly exercise his prerogative for that purpose.

"We have faithfully observed the injunction placed upon us by the framers of our original constitution and by-laws, who in preparing the preamble to it expressed themselves as follows: 'We the undersigned railway master mechanics believe that the interests of the companies by whom we are employed may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business.' Excellent reasons were these for the establishment of this association, and sufficient are they for continuing its existence. But there is urgent need for extending our operations beyond the mere confines of the exchange of ideas and methods.

"As a technical association we stand unique and alone in the field of railway mechanical engineering, no other country to my knowledge having a like organization performing like work. True, we have an esteemed body in this country, known as the American Society of Mechanical Engineers, of which I have the honor to be a member, but the work of that society and its field of research are so far removed from the practical everyday problems in railroading that as a society it is of but little value to the railway mechanical fraternity. It is, therefore, incumbent upon this association to assume a stronger role, and, in addition to holding our annual experience meetings, to get closer together and concentrate our efforts on unifying mechanical opinions on matters of design, construction, specifications, formulæ and policies.

"Possibly we have not had the encouragement we should have received from our superiors, and have not been drawn upon heavily enough to arouse within us the latent powers we possess; consequently without this call upon us we have, as might be expected, assumed a more or less dormant attitude in relation to research work. But it is safe to predict that, with the past two or three years of both national and state legislative activity covering subjects the consideration of which properly belongs to this body, we will in the near future be called upon for action much more strenuous, exacting and positive than we have ever experienced before.

"With this idea in view, and realizing the many vexing problems we as mechanical men will have to solve, I wish to advocate for your most serious consideration the establishment of a permanent centralized technical bureau within our association to be composed of active members of the association having strong technical and practical training, and to have associated with them the officers of the association as members ex-officio. This body should be clothed with authority to act for the association on all important questions arising in the interim between our annual meetings, making a full report to the association in convention assembled at the first opportunity.

"I would further suggest for your consideration that one member of this bureau be a salaried incumbent, the permanency of the office and the emoluments to be such as to permit of its acceptance by an individual fully equipped through experience and training to cope with any and all questions demanding his attention, and who will at all times keep the central body well posted as to the general happenings of interest throughout the country, collect such data as may be required by the body and direct such investigations and research work as may be assigned to him.

"It is also quite necessary that we as an association be more of a unanimous mind on questions that are likely to call for or be made the subject of either federal or state legislation. Such questions should be anticipated and acted upon as far in advance as possible, and then when real legislative action is begun a precedence will have been established, so that the dominating and impelling forces which shape the opinions and recommendations of legislative committees will not emanate from the leader of some political clan or labor organization, but will be found recorded in our proceedings and practices as the crystallized judgment of the members of this great engineering body, whose opinion cannot long be ignored.

"Examples covering the points I have tried to make with reference to getting together are many and varied. Your attention is called to a few which seem to cover the ground fully and will, I hope, substantiate the position I have taken.

"A bill recently introduced in Congress, known as the Federal Boiler Inspection Bill, has created quite a furore and not a little anxiety among railway managers throughout the country. This bill was forced to the front by politicians urged on by labor organization leaders, and it was necessary on the part of this association to take some action in opposition to the forces at work. To this end, although resembling quite closely an eleventh hour repentance, a committee on boiler design, construction and inspection was appointed at the first meeting of our executive committee held at Cleveland last July. This committee has done splendid work in collecting and tabulating data which we hope will enable the American Railway Association committee finally to prosecute successfully its contentions before the House and Senate committees having the bill in charge, but it is well known that the data furnished the committee by the various railways lacked harmony. The opinions and suggestions offered were often diametrically opposite and the whole presented such a lack of uniformity and agreement that it was bewildering, and to glean anything tangible from the mass required almost superhuman effort.

"As members of this association we have had more or less to do with the design and construction of locomotive boilers during the past forty-three years, and as railway mechanical men many years longer, yet we are not agreed on the very simple and fundamental question of the factor of safety for locomotive boilers. As a consequence of this lack of agreement some of us are now facing the peculiar dilemma of strengthening locomotive boilers now in service both new and old or of prevailing upon the Public Service Commission to reduce the requirements which they arbitrarily established in the absence of an authoritative standard.

"The locomotive headlight question has furnished legislators in many states with a big stick of harassing proportions. On this question, as on many others, we as an association have about as many opinions as we have members, the opinions ranging from the declaration by some that the headlight is an expensive nuisance and should be abolished to the declaration by others that it is a necessary and valuable adjunct and should be of several thousand candle-power.

"It is my opinion that such questions as I have mentioned, as well as purely technical questions, covering design and construction, are well within the work to be covered by this association, and especially the work of the bureau I advocate. Similar problems will arise as long as railways operate, whether the motive power be steam, electricity or something else, and it is our plain duty to provide some medium through which all vital subjects can at all times be fully and thoroughly investigated, and to be in a position at all times to present a united front on all questions involving the common interests of all railways."

REPORT OF SECRETARY.

The report of the secretary showed the membership to be as follows: Active, 952; associate, 20; honorary, 37; total, 1,009. During the year the secretary received $5,466.56 and expended $5,433.40, leaving a balance of $33.16. The treasurers' report showed the balance on hand June 20, 1910, $6,229.94.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year:

President, C. E. Fuller.

1st Vice-President, H. T. Bentley.

2nd Vice-President, D. F. Crawford.

3rd Vice-President, T. Rumney.

Treasurer, Angus Sinclair.

New Members of the Executive Committee: T. H. Curtis, F. F. Gaines and G. W. Wildin.

SAFETY APPLIANCES.

This subject was referred to the executive committee with the suggestion that they prepare a statement to be sent to each member giving in full the attitude of the Interstate Commerce Commission on the subject of "Safety Appliances for Locomotives.'

TRAIN BRAKE AND SIGNAL EQUIPMENT

This report, in abstract, is printed in connection with the proceedings of the M. C. B. Association, in another part of this issue.

A number of corrections were presented by Mr. Pratt and on motion the report was received and will be submitted to letter ballot.

EDUCATION AS AN ESSENTIAL OF FUEL ECONOMY.

INDIVIDUAL PAPER BY W. C. HAYES*

The best plan to accomplish a saving in the amount of fuel consumed by locomotives on any railroad is a perplexing problem, and one that is forcing itself upon the attention of motive power and managing officers with moving effect, as the operating costs increase and the opportunity for reductions is narrowed to the limit in other channels. Hence, the interest in this question must of necessity increase and every phase of it be closely watched and guarded by those directly in charge and brought up to date, so the subject may be handled in a concrete and systematic way that will correlate all the details to improve the service, with progressive reduction in fuel consumption always in view.

This paper will be confined to and deal largely with that phase of the question having to do with the instruction and educational development of enginemen; in doing so, its scope will be to deal with methods of supervision and instruction of engineers, firemen, hostlers, engine preparers and all others having to do with the preparation of engines for service, so far as maintaining or raising steam on locomotives in service is concerned. The above phases of the subject will be considered under the following heads:

1. Methods of the selection of candidates for the position of firemen.
2. Educational plan recommended before employment.
3. Educational methods to be religiously followed after employment.
4. The methods of education to be followed out on the most approved plan, such as, for instance, a well defined system of instruction, both by class and individual scheme, to be in charge of the road foreman of engines, or a supervisor of locomotive operation.
5. The above to be followed by both written and verbal examinations, to be conducted by the road foreman of engines or by the supervisor of locomotive operation, or a committee that may be selected for that purpose.

Methods of selecting candidates for the position of fireman.

The old hit-and-miss plan, in fact, the one generally followed at this time on most all railroads, consists of hiring a number of men and trying them out by giving them a letter as a learner or student fireman, requiring them to spend a certain specified time learning the duties they will be called upon to perform before being assigned to duty under pay, such as, for instance, riding four or five trips on different classes of engines in the varying grades of service, passenger, switch, freight and helping, receiving instructions from engineers and firemen with whom they may ride.

The latest plan presented, that appeals very strongly to the writer, is one recently introduced by Mr. George H. Baker, president of the American Correspondence School, Brooklyn, N. Y. The plan operates as follows:

A railroad company grants permission to its station agents to act as the representatives of his correspondence course, allowing to each agent a small commission for each student secured. The "Baker plan" then undertakes to educate the candidate in proper methods of firing, incidentally covering all of the principles of combustion, together with instruction in train rules, signals, etc., so as to fit their students for actual service, as well as can be without having practically performed the work. The only responsibility the railroad company assumes is a quasi promise to give preference in employment to all such men as may be available for service when needed, and who can pass all the physical and other employment requirements of the railroad company.

The railroad company with which the author is connected has employed a number of these men on one of its important main line divisions, with very satisfactory results; in fact, in comparison with men who have been employed as firemen on this same division for three, four and five years, their work, in amount of fuel consumed, is more than favorable, and at this time these men are taking a far greater interest in their duties as firemen than are the elder men.

The best educational methods after employment.

Engineers and firemen should be required to fully post themselves in proper methods of combustion, making such a study of the subject as will enable them to apply in everyday practice its cardinal principles. Literature of a well-known character and value can easily be secured that will assist in every way in a study of all branches of the subject. This in all its essentials lays the foundation for progressive examinations of enginemen in fuel economy. The best plan is to furnish to all enginemen a printed list of questions, answers being required in writing, upon which a plan of oral examinations can be based. These examinations to be made either by a committee composed of the master mechanic, road foreman and some general officer who may be delegated for that duty by proper authority, or through any other medium that may suggest itself.

Railroads carrying a sufficient force of road foremen to properly supervise their work, so that they are able to ride with and instruct each individual engineer and fireman, personally, in the proper performance of their duties, in order to see that object-lessons that are given as examples of correct work are being absorbed and instructions are faithfully adhered to, will find that even this sort of supervision can be materially reinforced by holding periodically schools of instruction, in which class lessons can be arranged for the purpose of discussing any one or all of the subjects under which an improvement in fuel and other economies can be made that are directly under the control of the engine crew. This arrangement will have a tendency to spread out the good offices of the road foreman of engines and enable him to cover a much larger field than would be otherwise possible.

The following illustration is presented as an example of what can or may be accomplished by competent supervision and instruction, closely followed to a logical conclusion:

A road foreman of a trunk line having charge of terminal work rode on one of his switch engines for two consecutive hours, and made the following observations: The first hour the pop valve was open continually and the engine was fired and operated by the crew in a slipshod manner. Black smoke was

*Superintendent Locomotive Operation, Erie R. R.

being produced at a great rate, for the reason that large quantities of coal were introduced at one firing and the operation of the engine presented altogether such an unskilful spectacle as to be truly alarming, so far as the visible waste of fuel was concerned. Not a word was said to the crew about their work during the first hour, but at its expiration the road foreman explained to the men in detail the bad features of their work and checked the amount of fuel wasted through these practices, so as to make the matter quite clear to them.

The second hour's operation resulted as follows: The pop valve was kept closed during the entire period; coal was introduced in much smaller quantities and with some degree of skill. Results—no black smoke and much coal saved. The following is the result:

	Lbs.
Coal consumed first hour, 116 shovelfuls at 18 lbs. per shovelful	2088
Coal consumed second hour, 40 shovelfuls at 18 lbs. per shovelful	720
Saving accomplished	1368

(The work done was more severe during the second hour.)

This, of course, is an extreme case, as no such saving can be made upon each engine, but it points the way and certainly shows the kind of supervision necessary in order to obtain best results.

Discussion.—G. H. Baker pointed out how during the past thirty years there had been a wonderful and constant improvement in every feature in connection with railroad operation with the almost single exception of the method of training firemen. These men, in a majority of cases, he said, were now chosen and instructed in practically the same way they were 30 years ago. He drew attention to the tremendous expense that was incurred yearly by the railroads due to this single feature and expressed the belief that it was all entirely useless and would not be permitted much longer. He suggested that it would be advisable for the associations to appoint a committee to investigate and report as follows:—

First, the desirability of preparatory instruction for locomotive firemen, to be mastered before employment. *Second*, the value in fuel economy and superior service, if any, effected by such instruction, as shown by actual comparison of the services of instructed and uninstructed firemen. *Third*, the subjects which proper preparatory instruction should teach. *Fourth*, the character of examination (oral or written) to ascertain if applicants properly understand the instruction, and should they be permitted to enter service without such examination, same to be completed within first month of service. *Fifth*, examine and report upon the merits and defects of any systems of preparatory instruction for firemen now in use.

T. E. Adams spoke at considerable length on this subject, it being one to which he has devoted a great deal of time and study and has been very successful in. His remarks might be summed up as an earnest plea for the determination of a correct principle of instructions. He believed that being determined the rest could easily be taken care of.

E. A. Miller pointed out that the changed conditions now made it much more difficult to obtain satisfactory firemen in any case. While the raw material might be as good as formerly, although in most cases this is not so, the work that they now have to do makes it very difficult to get good results. He believed that with the larger locomotives it is best to lighten the fireman's work as much as possible and that possibly the automatic stoker would eventually solve many of the difficulties of this kind.

Mr. MacBain again drew attention to the plan he had suggested at a previous convention, that he still believed would give the best results in this connection. That plan is to put on men to instruct the firemen, not one traveling fireman on a division to whom is also assigned a dozen other duties, but a man to every 60 or 70 firemen, who should have nothing else to do but instruct them in their work. In this connection he believed that the locomotives should be maintained in the best conditions as encouragement to the firemen to try for the greatest economy. He mentioned the brick arch as a fuel saver and believed that it should be applied to all locomotives possible.

C. W. Cross pointed out that the principles of apprenticeship can as readily be applied to firemen as machinists and stated that in 1903 the New York Central Lines established a set of three year progressive examinations that are best described by the preface of the examination book, which he read as follows:—

"It is the policy of railways to employ men as locomotive firemen who will be capable in time of becoming locomotive engineers. This requires that a man should have at least a common school education, good habits, and be in good physical condition. He should also be quick and alert and a man of sound judgment. Having these qualifications, advancement will come to those who are conscientious in the discharge of their duties and who devote some of their leisure hours to study. As an aid to this end and in order that there may be derived the highest efficiency from a man engaged as a locomotive fireman, there is placed in the hands of every man who is employed as a fireman a code of questions, and it is expected that in the preparation necessary for correct answering of the questions a course of study will be necessary which shall fit him for the work which he is expected to perform. His answers to the questions will indicate how well he has progressed.

"When a man is employed first as a fireman, he will be given the questions on which he will be examined at the end of the first year. Having answered these questions satisfactorily he will then be given the questions for the following year. Having passed this one, he will be given a third and final set of questions on which he will be examined before being promoted to engineman. It is not expected that a man will answer these questions without assistance, and in order that he may understand them properly there has been established a school of instruction in the use of the air-brake, to which all employees are invited; he is also invited to ask the master mechanic, general foreman, road foreman of engines (or traveling engineer), also air-brake supervisors (or instructors), or any other official, for such information as may be required on any of the questions or on any points in connection with the work. He is not only invited, but is urged to do this as the more knowledge the firemen possess the better the results which can be obtained. He will have ample time to study each set of questions, therefore there is no doubt but that with a reasonable amount of study each week the information required to answer satisfactorily the entire list of each series of questions can be easily mastered in the time given.

"In connection with this examination the work done by the fireman during the time of his service and how the work compares with that of other firemen engaged in the same class of service will be noted carefully; also his record as to the use of coal, oil, etc., will be taken into consideration. It is hoped that he will give everything in detail the consideration it merits and realize fully that it is by looking after the little things that a man succeeds. It should be borne in mind that it is only by filling well the position that one has that a person is entitled to the confidence that makes better positions possible."

The following describes the method and time of holding these progressive examinations: "When a man is employed as a fireman, he shall be given the first series of questions and be notified that at the end of the first year of the service he will be required to pass a written and oral examination thereon, under the direction of the division mechanical officer and air-brake supervisor or air-brake instructor. After passing the first series of questions he will be given the second series of questions and be notified that at the end of another year of service he will be required to pass a written and oral examination thereon, under the direction of the division mechanical officer and air-brake supervisor (or air-brake inspector). If a man fails to pass the first and second examinations, he shall be dropped from the service. If a man has passed 80 per cent or more in all examinations, he shall be given a diploma. When he has passed the second series of questions he will be given the third series of questions and be notified that before being promoted and within not less than one year he will be required to pass a written and oral examination before a general board of examiners. At the third examination, if a man shall fail to pass 80 per cent of the questions asked, two more trials, not less than two months apart, will be given him to pass the same examination. If he then fails to pass by a percentage of 80 per cent, he shall be dropped from the service. Firemen passing the third and final series of questions will be promoted in order of their seniority as firemen, except that those who pass on the first trial shall rank, when promoted, above those who pass on the second or third trial, and those passing on the second trial shall rank above those who pass on the third trial. Enginemen employed shall be required to pass the third series of questions before entering the service."

SELF DUMPING ASH PANS

H. T. Bentley (C. & N. W.) opened the topical discussion on this subject as follows: Are self dumping ash pans entirely satisfactory, and if not what should be done to make them so?

In accordance with Federal requirements we equipped our engines with self dumping or legal ash pans, and had all in operation by January 1 of this year. Before going into the application of them we made a careful study of the situation, and went over the drawings of practically every self dumping pan that was then in use, and decided, as we had a number of new engines from the locomotive builders equipped with the bottom slide apparatus, that it would be the most satisfactory arrangement for such engines. Therefore, after considerable thought, we worked up a design that would answer for the largest number of engines, and made standard for those engines the slide, hopper casting, operating rods, cranks, etc.

We had to settle a number of things that came up, such as an arrangement that could be worked from either side, a device that could not be opened from the deck so as to overcome the possibility of dumping live cinders on bridges, etc., where they might cause trouble; make provision for thawing them out in winter, and provide sufficient openings for air to enter without letting fire out. We designed every part amply strong and felt that we were going to be rewarded by having a device that would be reasonably free from causing us trouble, but have been disappointed, and in making inquiries from our neighbors find they have all had more or less difficulty with pans warping and getting out of shape, so that live cinders were dropped, setting fires, and causing other trouble. During cold weather the slides would freeze solid, notwithstanding the fact that we had a heater attached to each one to overcome this difficulty.

It has been suggested that we make the hopper entirely of cast iron, but in looking over pans on other roads we find they have tried this and had to abandon its use, substituting cast steel, which apparently is very little better. On a road having all steel bridges, and running through a well settled territory, the dropping of a few live cinders is not a serious matter, but out in the country, with wooden bridges, dry grass, etc., it is a different proposition. It has been proposed that we have a water connection from the boiler to the ash pan so that occasionally the live cinders can be wetted down. This may be satisfactory in summer, but in winter it might cause trouble. Some people have turned the injector overflow in the pan, which might be satisfactory in the south, but in the north the pan might freeze up.

A number of roads use a steam jet for blowing cinders out of flat bot-pan, and we understand it works satisfactorily with certain kinds of fuel, but with Iowa or Illinois coal we are afraid the clinkers could not be blown out with steam. The object of this paper is to bring about a discussion as to the difficulties or troubles experienced as a result of the ash pan bill that was passed, and what can be done to overcome them.

Discussion.—J. F. DeVoy stated that he believed the association should enter a very strenuous protest against the passage of bills compelling railways to apply devices which in many cases are an absolute detriment to locomotives.

FREIGHT TRAIN RESISTANCE; ITS RELATION TO AVERAGE CAR WEIGHT.

By Edward C. Schmidt.

Train resistance varies not only with the train speed, but also with the average weight of the cars of which the train is composed. At a given speed the tractive effort required for each ton of weight of the train will be greater, for example, for the train which is composed of cars of 20 tons average gross weight than for the train composed of cars which weigh, on the average, 50 tons each.

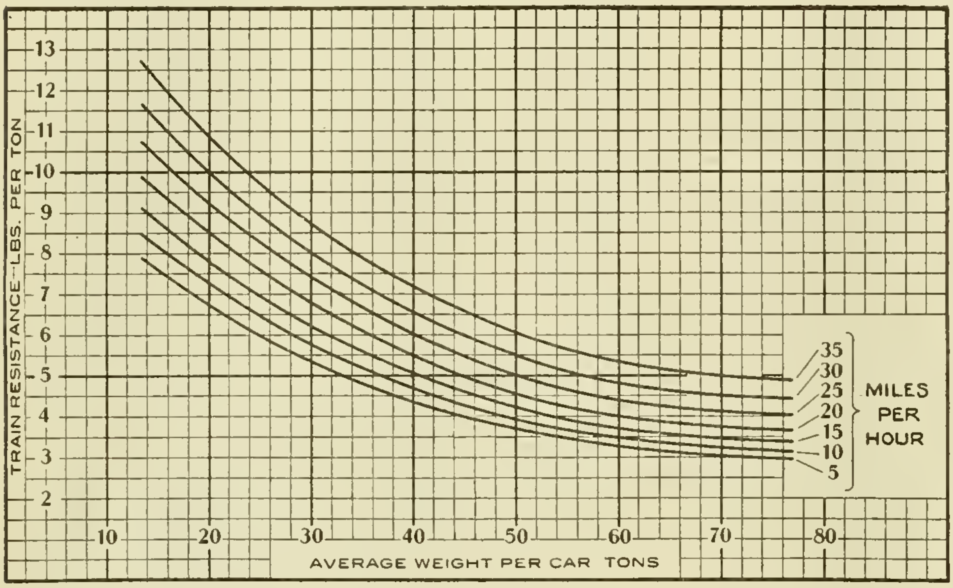


FIG. 1.

While this fact has been known for some years, it has found inadequate expression and but little application. In the establishment of their tonnage ratings many railroads have altogether ignored it. In the tonnage ratings of a few roads this variation of resistance with car weight is recognized to the extent of allowing a difference in rating between trains composed of loaded cars and those consisting entirely or partially of empty cars. Generally in such systems a certain amount is allowed arbitrarily to be added to the weight of empty cars in determining, for purpose of rating, the weight of the train in which they are found. In such ratings no distinction is made between loaded cars of various weights, although such weights vary from 25 to 70 tons. A still smaller group of railroads have fully recognized the significance of the facts above stated in establishing their tonnage ratings, which in such cases are usually termed "adjusted" or "equated" ratings. Under these adjusted ratings the actual weight of the train allotted to a particular locomotive varies according to the number of cars in the train. The ratings for the same locomotive with trains of 40, 60 and 80 cars, for example, will be different in each of the three cases. This, of course, is, in effect, a variation of the rating with respect to the average car weights. Most of these adjusted ratings have been empirically determined. In the few cases where they rest upon experiments made to determine the variations in train resistance with respect to car weight, the data and results of such experiments have not been fully published. Existing train resistance formulæ likewise fail in most cases to take into account these variations of resistance with car weight, and probably much of the divergence among them is properly to be ascribed to this fact.

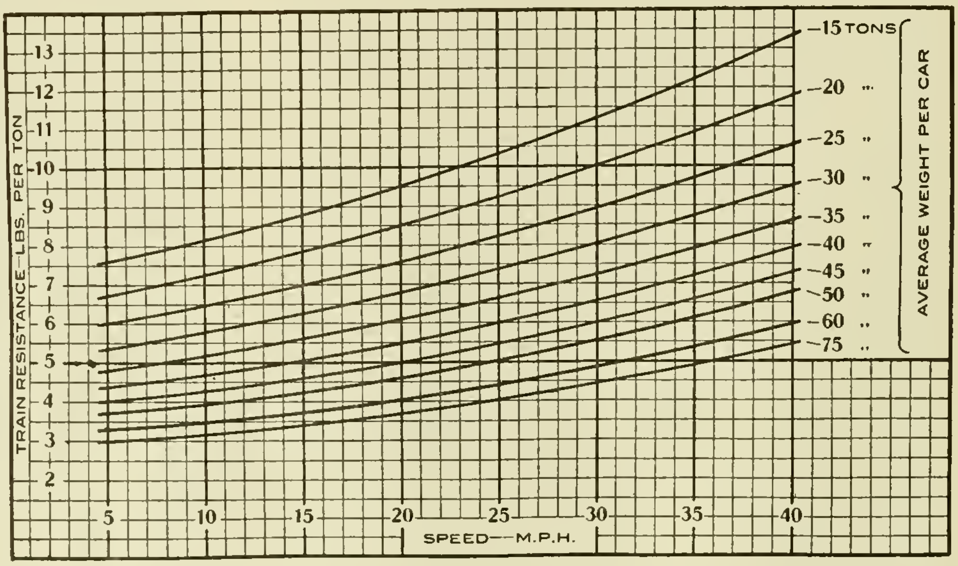


FIG. 2.

Purpose of the Tests.—In view of the facts just stated it has seemed desirable to make the tests whose results are here recorded. They were planned to determine the resistance of freight trains under the usual conditions of operation; and were designed to disclose at the same time, if possible, the relation existing at any given speed between train resistance and average car weight. Since the chief use of such information is in the production of locomotive ratings, the condition of the tests have been made like those which prevail in normal freight train operation. The speed range, for example, is from 5 to 35 miles per hour, and the trains experimented upon were trains in regular service and usual in their make-up. The track upon which the tests were made is believed to be representative of good main-line construction.

The tests have been made as part of the research work of the Engineering Experiment Station of the University of Illinois, conducted by the Railway Engineering Department. They were begun in April, 1908, and were completed in May, 1909. All tests were made by means of Test Car No. 17, a dynamometer car, owned jointly by the University of Illinois and the Illinois Central Railroad, and were carried out on the Chicago Division of this road.

In the preparation of the report the aim has been to present it in as brief a statement of the results and conditions as is compatible with a clear understanding of the tests. The original report of these tests was presented to the American Society of Mechanical Engineers, and has been published in the Society journal for May, 1910. The results of the tests will also be published as a bulletin of the Engineering Experiment Station of the University of Illinois. This bulletin will contain, in addition to the facts here published, more detailed information concerning the track, the dynamometer car and the methods of calculation, as well as the tonnage record for each train and the calculated results and resistance curve for each test.

Throughout the report the terms "resistance" and "train resistance" mean the number of pounds of tractive effort required for each ton of the train in order to keep it in motion on straight and level track, at uniform speed and in still air. The report deals exclusively with the resistance of the train behind the locomotive tender. Locomotive and tender resistance are not discussed.

SUMMARY AND CONCLUSIONS.

Summary.—The report deals with the results obtained from tests of thirty-two ordinary freight trains, whose chief characteristics were as follows:

	Minimum.	Maximum.
Total weight, tons.........	747	2,908
Average weight per car, ton	16.12	69.92
Number of cars in the train	26	89

The trains whose average weights were less than 20 tons or more than 60 tons were composed of cars of nearly uniform weight; while those whose average car weights were between 20 and 60 tons were either homogeneous or mixed as regards the weight of the individual cars.

TABLE 3

VALUES OF RESISTANCE AT VARIOUS SPEEDS AND FOR TRAINS OF DIFFERENT AVERAGE WEIGHTS PER CAR

THE VALUES ARE DERIVED DIRECTLY FROM THE CURVES OF FIGURE 11 AND REPRESENT THE FINAL RESULTS OF THE TESTS

SPEED MILES PER HOUR	TRAIN RESISTANCE — POUNDS PER TON (COLUMN HEADINGS INDICATE THE AVERAGE WEIGHTS PER CAR) 15 TONS	20 TONS	25 TONS	30 TONS	35 TONS	40 TONS	45 TONS	50 TONS	55 TONS	60 TONS	65 TONS	70 TONS	75 TONS	SPEED MILES PER HOUR
5	7.6	6.8	6.0	5.4	4.8	4.4	4.0	3.7	3.5	3.3	3.2	3.1	3.0	5
6	7.7	6.9	6.1	5.5	4.9	4.4	4.1	3.8	3.5	3.3	3.2	3.1	3.0	6
7	7.8	7.0	6.2	5.5	5.0	4.5	4.1	3.8	3.6	3.4	3.2	3.1	3.1	7
8	8.0	7.1	6.3	5.6	5.0	4.6	4.2	3.9	3.6	3.4	3.3	3.2	3.1	8
9	8.1	7.2	6.4	5.7	5.1	4.6	4.2	3.9	3.6	3.4	3.3	3.2	3.1	9
10	8.2	7.3	6.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3	3.2	3.2	10
11	8.3	7.4	6.6	5.9	5.3	4.8	4.3	4.0	3.7	3.5	3.4	3.3	3.2	11
12	8.4	7.5	6.7	6.0	5.4	4.8	4.4	4.0	3.8	3.6	3.4	3.3	3.3	12
13	8.6	7.6	6.8	6.1	5.5	4.9	4.5	4.1	3.8	3.6	3.5	3.4	3.3	13
14	8.7	7.8	6.9	6.2	5.5	5.0	4.5	4.2	3.9	3.7	3.5	3.4	3.4	14
15	8.8	7.9	7.0	6.3	5.6	5.1	4.6	4.2	3.9	3.7	3.6	3.5	3.4	15
16	9.0	8.0	7.1	6.4	5.7	5.1	4.7	4.3	4.0	3.8	3.6	3.5	3.5	16
17	9.1	8.1	7.2	6.5	5.8	5.2	4.8	4.4	4.1	3.9	3.7	3.6	3.5	17
18	9.3	8.3	7.4	6.6	5.9	5.3	4.8	4.5	4.1	3.9	3.7	3.7	3.6	18
19	9.4	8.4	7.5	6.7	6.0	5.4	4.9	4.5	4.2	4.0	3.8	3.7	3.6	19
20	9.6	8.5	7.6	6.8	6.1	5.5	5.0	4.6	4.3	4.0	3.9	3.8	3.7	20
21	9.7	8.7	7.7	6.9	6.2	5.6	5.1	4.7	4.3	4.1	3.9	3.9	3.8	21
22	9.9	8.8	7.9	7.0	6.3	5.7	5.2	4.8	4.4	4.2	4.0	3.9	3.8	22
23	10.0	9.0	8.0	7.1	6.4	5.8	5.3	4.9	4.5	4.3	4.1	4.0	3.9	23
24	10.2	9.1	8.1	7.3	6.6	5.9	5.4	4.9	4.6	4.3	4.2	4.1	4.0	24
25	10.4	9.3	8.3	7.4	6.7	6.0	5.5	5.0	4.7	4.4	4.2	4.1	4.0	25
26	10.5	9.4	8.4	7.5	6.8	6.1	5.6	5.1	4.8	4.5	4.3	4.2	4.1	26
27	10.7	9.6	8.5	7.7	6.9	6.2	5.7	5.2	4.8	4.6	4.4	4.3	4.2	27
28	10.9	9.7	8.7	7.8	7.0	6.3	5.8	5.3	4.9	4.7	4.5	4.4	4.3	28
29	11.1	9.9	8.8	7.9	7.1	6.5	5.9	5.4	5.0	4.8	4.6	4.5	4.4	29
30	11.3	10.0	9.0	8.0	7.3	6.6	6.0	5.5	5.1	4.9	4.7	4.5	4.5	30
31	11.4	10.2	9.1	8.2	7.4	6.7	6.1	5.6	5.2	5.0	4.8	4.6	4.5	31
32	11.6	10.4	9.3	8.3	7.5	6.8	6.2	5.8	5.3	5.0	4.9	4.7	4.6	32
33	11.8	10.5	9.4	8.5	7.6	7.0	6.3	5.9	5.4	5.2	5.0	4.8	4.7	33
34	12.0	10.7	9.6	8.6	7.8	7.1	6.5	6.0	5.5	5.3	5.1	4.9	4.8	34
35	12.3	10.9	9.7	8.8	7.9	7.2	6.6	6.1	5.7	5.4	5.2	5.0	4.9	35
36	12.5	11.1	9.9	8.9	8.0	7.4	6.7	6.2	5.8	5.5	5.3	5.1	5.0	36
37	12.7	11.2	10.0	9.0	8.2	7.5	6.9	6.4	5.9	5.6	5.4	5.2	5.1	37
38	12.9	11.4	10.2	9.2	8.3	7.6	7.0	6.5	6.0	5.7	5.5	5.3	5.2	38
39	13.1	11.6	10.4	9.4	8.5	7.8	7.1	6.6	6.2	5.8	5.6	5.4	5.3	39
40	13.4	11.8	10.6	9.5	8.6	7.9	7.3	6.8	6.3	6.0	5.7	5.6	5.5	40

The tests were made during generally fair weather. The minimum air temperature during any test was 34 degrees; the maximum, 82 degrees. The approximate average wind velocity prevailing throughout one test was 25 miles per hour; during all the others it was less than 20 miles per hour.

The tests were made upon well-constructed and well-maintained main-line track, 94 per cent. of which is laid with 85-pound rail, the remainder being laid with 75-pound rail. Except through station grounds, where screenings or cinders are used for ballast, the track is full ballasted with broken stone.

Conclusions.—The results of the tests are presented in Figs. 1 and 2, in Table 3, and in the equations (Fig. 3). The curves, the table and the equations are each different expressions of the same facts. It is believed that by their use one may safely predict the probable total resistance of *entire* freight trains at various speeds, when running upon straight and level track of good construction during weather when the temperature is above 30° F. and the wind velocity is not more than 20 miles per hour, provided the *average* weight of the cars composing the train be known.

The results are applicable to trains of all varieties of make-up to be met with in service. They may be applied, without incurring material error, to trains which are homogeneous and to those which are mixed as regards individual car weight.

The results are primarily applicable to trains which have been for some time in motion. When trains are first started from yards, or after stops on the road of more than about twenty minutes' duration, their resistance is likely to be appreciably greater than is indicated by the results here presented. In rating locomotives no consideration need be given this matter, except in determining "dead" ratings for low speeds, and then only when the ruling grade is located within six or seven miles of the starting point or of a regular road stop.

It is to be expected that some trains to be met with in service will have a resistance about 9 per cent. in excess of that indicated by Figs. 1 and 2, due to variations in make-up or in external conditions within the limits to which the tests apply. If operating conditions make it essential to reduce to a minimum the risk of failure to haul the allotted tonnage, then this 9 per cent. allowance should be made. This consideration, like the one preceding, is important only in rating locomotives for speeds under 15 miles per hour. At higher speeds, the occasional excess in the resistance of individual trains will result in nothing more serious than a slight increase in running time. It should be emphasized that this allowance, if

Train Resistance Formulæ—

When	$W = 15$ tons;	$R = 7.15 + 0.085\ S + 0.00175\ S^2$.
"	$W = 20$ " ;	$R = 6.30 + 0.087\ S + 0.00126\ S^2$.
"	$W = 25$ " ;	$R = 5.60 + 0.077\ S + 0.00116\ S^2$.
"	$W = 30$ " ;	$R = 5.02 + 0.066\ S + 0.00116\ S^2$.
"	$W = 35$ " ;	$R = 4.49 + 0.060\ S + 0.00108\ S^2$.
"	$W = 40$ " ;	$R = 4.15 + 0.041\ S + 0.00134\ S^2$.
"	$W = 45$ " ;	$R = 3.82 + 0.031\ S + 0.00140\ S^2$.
"	$W = 50$ " ;	$R = 3.56 + 0.024\ S + 0.00140\ S^2$.
"	$W = 55$ " ;	$R = 3.28 + 0.016\ S + 0.00142\ S^2$.
"	$W = 60$ " ;	$R = 3.19 + 0.016\ S + 0.00132\ S^2$.
"	$W = 65$ " ;	$R = 3.06 + 0.014\ S + 0.00130\ S^2$.
"	$W = 70$ " ;	$R = 2.92 + 0.021\ S + 0.00111\ S^2$.
"	$W = 75$ " ;	$R = 2.87 + 0.019\ S + 0.00113\ S^2$.

FIG. 3.

made, is to be added to the resistance on level track—not to the gross resistance on grades.

Discussion.—Mr. Bentley (C. & N. W.) asked the author concerning his experience with the resistance of different size journals carrying the same total load, that is, it is the general opinion of trainmen that a car having 4¼ by 8 in. journals and containing a certain load gives less resistance than a car with 5½ by 10 in. journals having the same total load. Prof. Schmidt replied by stating that there were no particular experiments made on this point but that theoretically it would be a fact that the smaller journals would offer less resistance.

Mr. Seley drew attention to the fact that this was the first paper relating to tonnage rating that had been presented for a number of years and stated that the earlier papers had been found to be of great practical value and this one would undoubtedly prove to be no exception. He regarded it as a very valuable contribution to the association and moved a vote of thanks to Prof. Schmidt. This motion was carried.

MECHANICAL STOKERS.

Committee:—T. Rumney, Chairman; E. D. Nelson, C. E. Gossett, J. A. Carney, Geo. Hodgins.

The report of the committee contained descriptions of the Crawford stoker and the Street stoker, both of which have been developed since last year. Both will be the subject of separate articles in a later issue of this journal.

It also contained some references to the service of the stokers that were described in last year's report, showing that in general they are operating satisfactorily. The report concluded as follows:

Our experience has developed that the stoker is not mechanically perfect. Therefore, it requires considerable skill and care on the part of the enginemen to avoid failures. The stoker companies have made several improvements in the design of the machines in the past year, and, in view of the improvements that have been made that have so materially improved its performance, it is reasonable to assume that this machine will yet prove a successful device for automatic firing of locomotives.

It could hardly be expected that mechanical stokers at the present stage of development could show an economy over hand firing by an expert fireman, but it is considered that, if economy is expected, it must be looked for in the comparison with the average of all grades of firemen in regular service. Designers of the present day are more interested in effecting practicability and security against failure rather than the promoting of efficiency by its use, as this effect is more or less taken for granted with any properly designed and thoroughly practical stoker.

The main defect of the present stokers seems to be, to a very great extent, with the coal-conveying apparatus, and it is the failure of this particular feature which usually makes the stokers of to-day somewhat unreliable.

The committee considers the progress and the development of the mechanical stokers during the past years as indicative of a determined effort to build stokers which will be in every way a success, and is convinced that the mechanical stoker is destined to be a very important factor in the operation of heavy locomotives in the not very distant future.

Discussion—Mr. Street stated that his stoker was in service on the Lake Shore & Michigan Southern Railway, between Ashtabula and Youngstown, Ohio, and invited any one interested to take a ride on the locomotive and watch its operation. This invitation was seconded by Mr. MacBain.

T. O. Sechrist stated that there was a Hanna stoker working on a Mallet compound locomotive on the C. N. O. & T. P. Railway between Oakdale and Danville, Ky. This stoker had given most satisfactory results in that service and had shown itself capable of handling trains that were impossible with hand firing. They were now installing twelve more Hanna stokers on the same division and it is the intention to equip all of the largest engines with it. The stoker was able to satisfactorily use coal which cost ninety cents a ton as compared with $1.35 coal used when firing by hand.

J. F. DeVoy reported that the Strauss stoker, which had been in operation on the Milwaukee for over a year, had been giving very satisfactory results and quoted from official reports many trips which showed the stoker to be successful in every way.

J. F. Walsh stated that five Strauss stokers used on the C. & O. were giving as good results as hand firing on their very large engines. The locomotives equipped with stokers are working on the river grade, handling trains of 4,500 tons. He expressed the opinion that the stoker to be thoroughly satisfactory must be made more attractive to the firemen. Means should be provided for conveying the coal from the tender to the hopper.

Mr. Franey stated that he had personally fired the engine equipped with the Street stoker for fifty miles, the train weighing 3,400 tons, and that during this trip he did not find it necessary to remove a heavy overcoat. It was not necessary to open the fire door during the whole trip. He also reported a number of other trips which he had personally made on the locomotive that showed excellent results. He stated that observations indicate a considerable saving of coal by the use of a stoker, and that tests were now being made to verify this. In regard to smoke the density depended upon the amount of coal being fired. With heavy firing black smoke was emitted constantly. With lighter firing the smoke was a lighter color, but was still constant. He stated that the maintenance of the stoker had proved to be very light.

Mr. Bentley did not agree with the gentleman who stated that the stoker could be used satisfactorily by inexperienced men. He believed that no matter which stocker was used it would be necessary for the fireman to have considerable experience in order to get the best results from it. He also brought up the question of smoke as being very important and stated that in the large cities this was one of the most serious problems that the stoker is expected to remedy.

Mr. Hayes stated that on the Erie experience with stokers so far had not been such as to justify any general expression in their favor. There has been five or six stokers in service on that road and it was found that they took about one-third more coal than hand firing. He believed that the education of the firemen would accomplish better results than the stoker unless the latter was greatly improved over those that he knew.

George L. Fowler reported a recent trip with the Crawford stoker and stated that its operation was entirely smokeless. While no tests had been made as yet, observations indicated that this stoker gave some fuel economy. It was entirely successful so far as keeping up the steam was concerned.

LOCOMOTIVE FRAME CONSTRUCTION.

By H. T. Bentley.

The subject of the paper I was asked to write was subdivided under two heads, as follows:

First: The investigation of design of driving boxes, brasses, shoes, wedges, binders and frames, that will give increased mileage to locomotives between shoppings.

Second: Frame construction for engines with outside valve gear.

With our heavy locomotives, it is getting to be quite a problem to keep them running without having frequently to drop wheels and refit driving-box brasses, take up lateral wear, line down wedges, etc., and the object of this paper is to bring out a discussion as to what has been, or can be, done to keep engines off the drop pit, and increase their life between general repairs. We are nearly all agreed, I think, that if it were possible to keep our driving-box brasses, shoes and wedges snug, and free from pounding, there would be less trouble with frame breakage, and our rod brasses would not need renewing so often.

With the above ideas in mind, I am giving a few suggestions that may possibly enable us to keep an engine out of the shop until such time as the driving axles need renewing, unless a frame breakage occurs to take engine out of service.

To get the best results, driving boxes should be made of cast steel, and designed of such proportions in shoe and wedge fit as to give long life, and with an adjustable or removable hub liner, so that lateral motion could be taken up with wheels in place.

The driving-box brasses should be of ample size and made of suitable material for obtaining long life, and of a removable type so that it would be possible to quickly replace them without having to drop wheels.

Shoes and wedges should be of such a size so that a large bearing surface would be in contact with driving boxes. With the ordinary design, the shoe and wedge face is altogether too small, and very rapid wear takes place. Flangeless shoes and wedges should be used to overcome the trouble experienced with flanges breaking. To facilitate the lining down of wedges, arrangements should be made so that they could be removed without disturbing the binders, or underhung springs, if used; the wedge bolts should be of sufficient strength and so arranged that in case of breakage it would be an easy matter to replace them.

Binders to be so designed that they will securely hold the frame jaws together, and prevent movement, but yet of such construction that they can readily have wear taken up when necessary.

Frames.—Most roads have more or less trouble with frame breakages, and, if these could be eliminated by either improving the design or making them of some material that would stand up under the shocks they are subjected to, a step in the right direction would be made.

In looking over a mechanical paper some time ago, I noticed an article bearing on the great amount of frame breakage that was occurring with engines having the Walschaert valve gear. Upon looking into this, on our own road, I found we are not having the slightest trouble; not a single case of frame breakage has occurred on any outside gear engine during the past four years.

Frame Construction for Engines with Outside Valve Gear.—As most locomotives are now being built with outside valve gear, there is very little difficulty in designing a suitable cross bracing that will add materially to strength and life of frames.

In sending out a Circular of Inquiry on the subject under discussion, a number of questions were asked, and the replies are summed up after each question, following:

Have you any suggestion to make in the way of improving the driving box now in general use, and, if so, what do you recommend?

Of twenty-six answers, sixteen replied, "No," whereas the balance suggested using heavy steel boxes, except in one case, where it was recommended that the pedestal jaws be spread farther apart, so that heavier *cast-iron* boxes could be used.

Have you any way of taking up lateral wear in driving boxes without removing them, and, if so, how is it done?

Very little has been attempted in this direction, although replies indicate there is a great need of something that will enable this to be done.

Are you using driving boxes with brasses that can be taken out without dropping wheels, and, if so, what kind, and are they entirely satisfactory?

Notwithstanding the desirability of such an arrangement, only five roads report using anything of the kind, and all are using the same patented device, experimentally; in three cases satisfactorily, in one case it has not been in service long enough to report on, while the fifth user did not find it entirely satisfactory, but did not state in what respect it failed.

What mixture or special metal do you use in driving-box brasses, and is it entirely satisfactory? Do you use grease for lubricating switch engines, and is it giving satisfaction? If not, what do you suggest?

In the first section of this question, most roads reply that they are making their own mixture, of copper 80 per cent., tin 10 per cent. and lead 10 per cent., with very satisfactory results, while a few are purchasing special brands, which give good service.

In answer to second part of question No. 4, there appears to have been a difficulty experienced while using grease in switch engines, and it early became evident that the kind of grease and perforated plates working satisfactorily on road engines would not answer the purpose for the slower moving switch engine, and, therefore, a thinner grease and perforated plates with larger holes were introduced, and this combination appears to give better results.

Do you use adjustable or solid shoes and wedges, and are they satisfactory?

The general practice appears to favor the solid shoe with adjustable wedge, and, as a whole, is satisfactory, although with limited bearing surface considerable wear takes place. With engines having Walschaert or other outside gear, there is no reason why the frame jaws cannot be designed to get a width of eight to ten inches, if desired, so that the pressure per square inch could be greatly reduced. On a large number of European engines a solid pedestal of great width is used, with very satisfactory results.

Do you have much shoe and wedge flange breakage? If so, how do you overcome it?

Considerable trouble appears to have been experienced in this direction, and has been overcome in some cases by using bronze shoes and wedges; in others, by thickening flanges where possible, and, on most roads, frame jaws are now rounded off so that a good fillet can be left in shoes and wedges. We have entirely overcome the breakage of flanges by simply leaving them off, and using side plates riveted on frame, the flanges of driving box coming in contact with these side plates, instead of the flanges of shoes and wedges as formerly.

What width of bearing face do you have on shoes and wedges where they come in contact with driving boxes?

The replies indicate that this varies on different engines and roads, the minimum being 4 inches with 7¾ inches as a maximum, depending on the size of engine. With Consolidation engines in service on the Chicago & North Western Railway we have a wedge face of 8¼ by 17½ inches, with a pressure per square inch of 122.8 pounds, as compared with our former standard freight engine with 6¼ by 17 inch wedge face, with a pressure of 184.72 pounds per square inch.

With outside valve-gear engines, have you tried to increase the width of shoe and wedge face, and, if so, how?

In no case does there appear to have been an attempt made, according to replies received, to increase frame jaws on engines having outside valve gear, and yet it is a simple proposition, and by doing so very much increased wearing surface could be obtained.

Have you any way of taking down wedges, without removing binders or driving box, and, if so, please furnish blue-prints?

In no case reported has this been attempted, although it can be accomplished by using flangeless wedges and cutting away the inside flange of driving box, on wedge side, and what was formerly a four or five hour job, depending upon size of engine, can be accomplished in less than an hour.

Do you use brass or cast-iron faced shoes and wedges, and which do you recommend?

The general practice appears to favor cast iron for this purpose, but a number of roads prefer bronze shoes and wedges where steel boxes are used, while a few people seem to like a bronze liner on steel box, and then use a cast-iron shoe and wedge. With this latter arrangement, we have not had very good results on account of difficulty keeping liners fast on box, and our present practice is to use cast-iron shoes and wedges against steel boxes in freight service, and bronze bearing on passenger engines.

Can you line down shoes and wedges without taking them out to apply liners, and, if so, how?

The replies are practically the same as to question 9, except that occasionally loose liners are inserted behind wedge, which, however, can only be done by taking binder down, so that what should be a simple job is a difficult and expensive one.

With underhung springs can you remove and replace broken wedge bolts without taking binders down, and, if so, please show how?

Where underhung springs are used, it seems impossible on most roads to remove or apply wedge bolts without removing springs. We had a similar difficulty, and practically overcame it by making binders with slotted holes, which enabled us to take out and replace wedge bolts with springs in place, thus reducing the job from a big to a small one.

Which type of binder do you find the most satisfactory, and why?

The pedestal cap type meets with most favor, as replies from fourteen roads indicate it is their preference, and that frame breakage is reduced where used. The strap binder is next best thought of, seven replies being in favor of it. The clamp over frame jaw lugs is used on four roads on account of simplicity, and only one road is in favor of using the thimble and bolt.

My personal preference is the pedestal cap type.

Have you anything to suggest in the way of a binder that will take up wear without having to be upset and refitted?

The replies of persons using the pedestal cap type indicate that this style of binder does enable the wear to be taken up with less trouble and expense than any other make, in which conclusion I concur.

What suggestion have you to offer in regard to frame construction on engines with outside valve gear?

The proper cross bracing of frames is the most logical use to make of the space that was formerly taken up by valve gear, and will do more to overcome frame breakage than almost anything else, is the general opinion. One suggestion is to use upper and lower rails over cylinder casting. This design can, and is used, however, with engines not having outside valve gear, and is a great help in reducing front frame breakages and loose cylinders.

Do you have as much trouble with frame breakage when using outside valve gear as you did when using Stephenson gear? If so, how do you account for it? If not, how do you account for it?

There seems to be a reduction of frame breakages with engines having outside valve gear, on account of them being provided with suitable cross bracing. In our experience with engines of exactly the same size and make, one having the inside, and the other the outside gear, the former are continually in the shop with broken frames, while the latter, with Walschaert gear, have never given us a minute's trouble in this direction; but frames are braced laterally, which we consider the cause of our freedom from breakage.

Do you use cross bracing between frames of outside gear engines? If so, does it stiffen up and reduce frame breakage?

Where outside gears are in use, the frames are generally braced laterally and with splendid results, judging from replies received. Some roads have had such short experience with outside geared engines that they are not in a position to report intelligently.

Have you any suggestions to make that will decrease the breakage of locomotive frames?

The suggestions offered are various, and may be summarized as follows: Heavier frames. Keep pounds out of driving boxes. All weight-carrying points on frames to be braced to boiler. Make frames of best material. Increase depth of frame in proportion to the tractive power. Make frames in one piece with large radii where possible. Good material properly used.

Do you use steel or iron frames? Which is most satisfactory?

Cast-steel frames, when properly designed and annealed, appear to be just as satisfactory as wrought iron. Great strides have been made in foundry practice during the past few years, so that first-class castings can be obtained.

In conclusion, I believe there is a great field ahead for the further study of this subject, so that repairs to driving boxes, shoes, etc., will be simplified, and work now taking several hours can be done in very much less time.

Discussion—Mr. MacBain recounted how six years ago the New York Central experimented by lengthening the driving box brasses on Atlantic type locomotives about 20 per cent. or from 12 to 14⅛ inches. The extension was permitted by shifting the eccentrics and putting them on an off-set eccentric rod. Previous to that time it was found that the left main brass would run from 35,000 to 40,000 miles. The first one of the wider bearing ran 122,500 miles and the wear was not greater on the left main brass than on the others. The same form was immediately applied to other engines and it has been used with uniformly good results since that time.

Mr. Gaines objected to the use of cast steel driving boxes. He stated that he was trying at present to substitute cast iron boxes for all the cast steel designs on his road. In connection with frames he stated that it was advisable to connect points on the frames wherever the weight is transferred, directly to the boiler; in this manner many frame breakages are avoided.

Mr. DeVoy stated that he believed the increased frame bracing was the reason for decreased frame breakage on engines having outside valve gear. He also believed that you could reduce the weight of the frames by fully 25 per cent. by the use of properly designed braces and that the combined weight of frame and braces would be 15 to 20 per cent. less than the frame which was not properly braced.

Mr. Bentley recounted his experience with removable driving box brasses which covered a service of a number of years. He stated that the savings which were obtained by removable brasses were truly remarkable. In connection with these braces they were using flangeless shoes and wedges with great success.

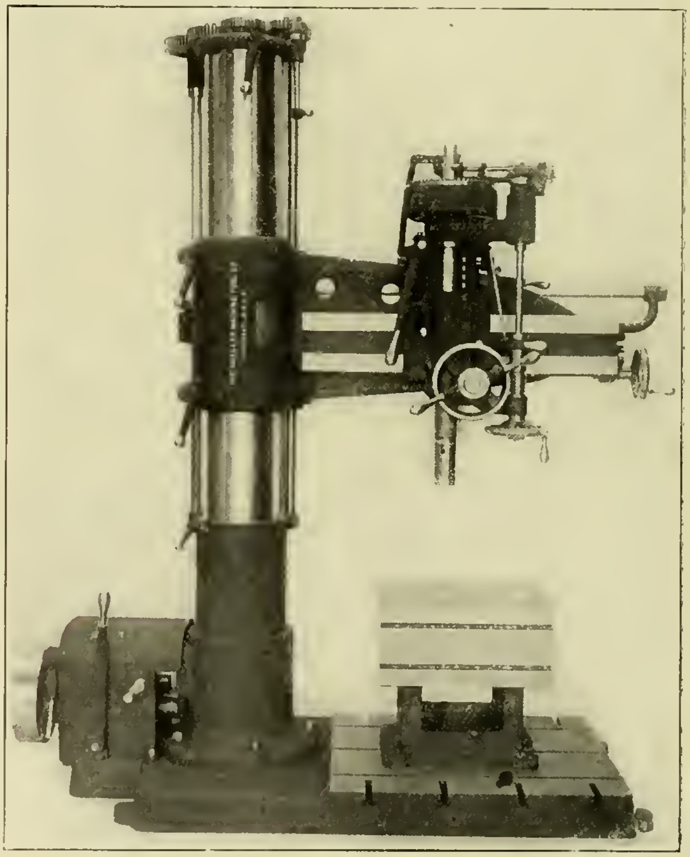
(Reports of committees and discussion on the following subjects will appear in the next issue: Superheaters; Capacity of Safety Valves; Design, Construction and Inspection of Locomotive Boilers; Locomotive and Shop Operating Costs, and Steel Tires.)

NEW DESIGN OF RADIAL DRILL.

A recent design of radial drill, adapted to accurate and fast work required in a modern railroad shop, is shown in the accompanying illustration. This drill is built in the 2½, 3 and 3½ foot sizes, making it suitable for all ordinary work.

It will be seen that the arm is very well proportioned and has a very wide bearing on the column, that is ground to size, making a very rigid arrangement. It can be lowered at twice the elevating speed, being controlled by a lever located on the cap of the column within easy reach. It can be swung in a full circle around the column.

The head is traversed by means of a double pitch screw, provided with a graduated dial on the end of the arm, which enables the operator to bring it to within .001 inches of the desired position. By means of a lever located on the head directly in front of the operator, the back gears can be engaged or disengaged without the slightest shock while the machine is in motion.



A GOOD DESIGN OF PLAIN RADIAL DRILL ADAPTED TO R. R. SHOP WORK.

High carbon crucible steel is used in the construction of the spindle, which is provided with an automatic trip with a safety stop. Another desirable feature is the range of twelve changes of speed which are instantly available without stopping the machine. In connection with this, there is a bronze speed plate on the arm which enables the operator to select the proper speed at a glance.

There are eight changes of feed in geometrical progression to each spindle speed, and the feed can be used either as a positive or as a friction feed.

Very heavy tapping operations are possible and it is claimed that it is impossible to break a tap on this machine because it is provided with an adjustable gauge nut which causes the spindle to slip when the tap reaches the bottom of a hole. The tapping mechanism permits taps to be backed out at accelerated speed.

Six changes of speed are provided by a speed box of the geared friction type which is simple in construction and easily operated.

The base of this drill is unusually heavy where the column is bolted on and the entire machine is very compact. It is made exceptionally rigid, eliminating all vibration, by casting the column in one piece with four internal ribs extending its entire length. The drill is manufactured by the Mueller Machine Tool Co., of Cincinnati, Ohio, and may be equipped for any style of motor drive. It can also be furnished with a universal box, plain swinging, worm swiveling, or round table.

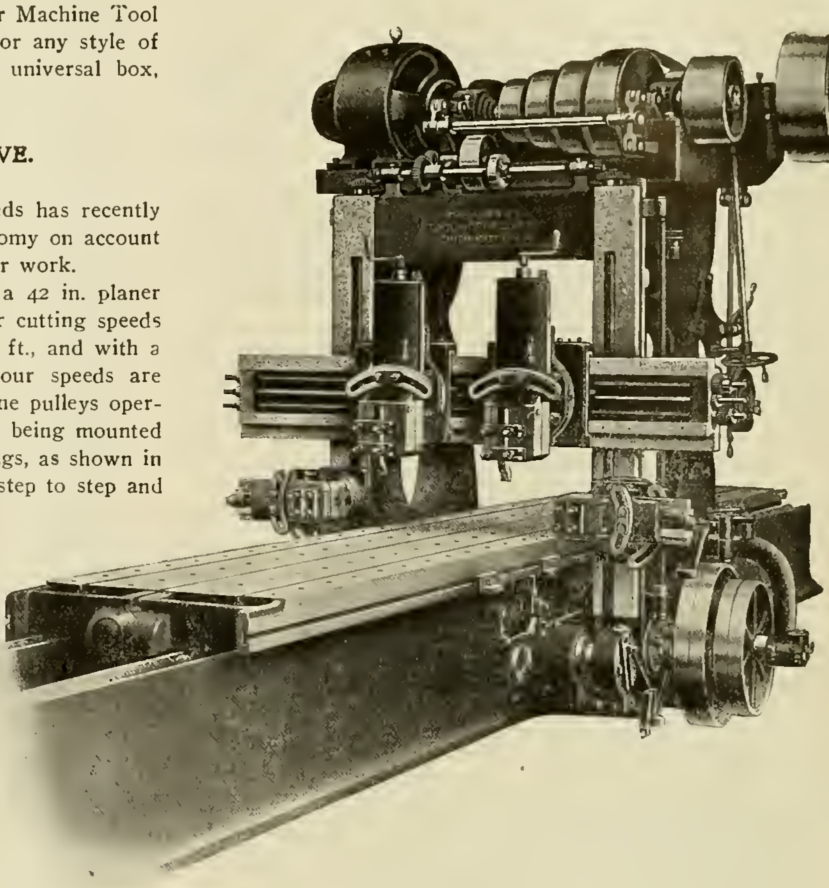
VARIABLE SPEED PLANER DRIVE.

A new planer drive with variable cutting speeds has recently been designed which insures great working economy on account of the flexibility provided for all classes of planer work.

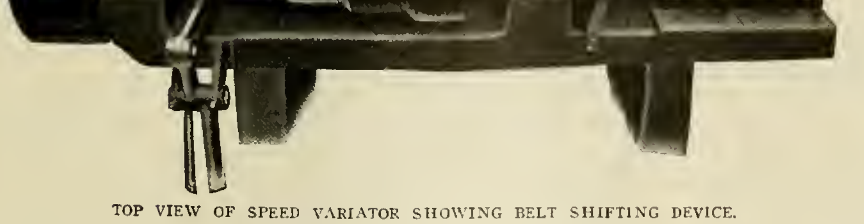
One of the accompanying illustrations shows a 42 in. planer fully equipped with this speed variator with four cutting speeds arranged to provide 20 ft., 30 ft., 40 ft., and 50 ft., and with a constant return speed of about 80 ft. The four speeds are obtained through a pair of opposed four step cone pulleys operated by an endless belt between them, the whole being mounted upon a substantial platform on top of the housings, as shown in the smaller top view. The belt is shifted from step to step and provides a range of speeds calculated to cover the most exacting requirements. These various cutting speeds, with the constant high speed return stroke, insure the greatest working economy.

This drive has primarily two distinct and necessary advantages over the old geared drive, in its simplicity of design and freedom from destructive vibration. There are no change gears to break or stick on the shafts, and the usual troubles due to frictions and jaw clutches, together with the splashing of oil over the machine, are eliminated. It is free from the noise and vibration of the gear driven type, which condition becomes worse as the parts are subjected to wear, on account of the excessive speed of the gears. Such vibration ultimately results in inaccuracy to the work being planed and hence unfits the geared drive for accurate planer work. This new speed variator is free from all these defects and insures the smoothest possible work, and its simplicity, efficiency and durability will appeal to those interested in this type of drive.

To accomplish the shifting of the belt effectively, a pair of belt forks are moved alternately along guide rods by means of a pair of cylindrical cams, which revolve alternately through the medium of a set of intermittent gears operated by the hand wheel shown at the rear. One revolution ot this wheel shifts the belt from one step to another and a shot pin indicates the complete revolution. The cam rolls have spiral slots milled in their peripheries, each belt fork being moved along the guide rods through the medium of a roller operating in the spiral slots. The relation between the cams and forks is such as to shift the belt from the high step of one cone before placing it on the high step of the opposing cone. The tension of the belt is controlled by the vertical lever, shown at the rear, operating in a radial slot. This lever is of convenient height and, through link connections, operates a pair of bell cranks which serve as levers to slide the driven cone towards the driver, thus slackening the belt. This feature, together with the mechanical belt shifting device and the fact that the steps of the pulleys are beveled on the edge, so as to offer no resistance to the passage of the belt, permits of easily making rapid changes of speed, even though the belt is very wide. After the belt is located for the desired speed, it is brought up tight by moving the hand lever to the point where the tension is sufficient for the work, after which the lever is securely clamped by the binder handle shown. In these operations the driven cone is moved towards the driver, that carries the planer driving belts; thus the tension of the vertical belts is not disturbed when making speed changes, and the danger of their flying off, from becoming loose, is overcome.



42" x 42" PLANER WITH VARIABLE SPEED MOTOR DRIVE.



TOP VIEW OF SPEED VARIATOR SHOWING BELT SHIFTING DEVICE.

All shafts in the variator are of large diameter, accurately ground and run in massive phosphor-bronze journals perfectly lubricated by the ring or dynamo system of oiling. The journals are supplied with liberal oil wells and return ducts, thereby preventing the oil from escaping and coming in contact with the belts. The bearings are of the ball and socket type, insuring perfect alignment at all times.

The fact that the speeds can be changed without stopping the machine constitutes a valuable feature, for with the old geared type it is necessary to wait until the mechanism slows down to almost a standstill before the clutches or gears could be engaged. With this drive in fact, it is far easier to make the changes while in motion than otherwise. The driving pulleys are perfectly balanced, and have flywheel rims, the momentum of which, even at high speeds, reduces to a minimum all shocks to the driving mechanism due to intermittent cutting and reversing, also insuring a steady, even pull for the cutting stroke. This, coupled with the smoothness of the drive, the good design and accuracy of the planer itself, insures finished work which is free from imperfections, requiring the least, if any, attention from the vise hands in subsequent fitting.

A belt drive is regularly furnished with the variator, the tight and loose pulleys being applied to the rear cone shaft. The drive can be obtained direct from a line shaft, provided same has a sufficient speed, but slow shafts of about 150 r.p.m. require an intermediate or jack shaft. The peculiar construction and design offer the additional advantage that it is a simple matter to convert the belt drive into a motor drive at any time after the machine is installed. For electric drive, as illustrated above, a constant speed motor is required, either of the direct or alternating current type, the motor being direct connected to the variator through spur gearing. A starting box is the only controlling mechanism necessary in this case.

The speed variator and also the planer are manufactured by the American Tool Works Co., Cincinnati, Ohio.

EXHIBITORS AT ATLANTIC CITY.

The exhibition of the Railway Supply Men's Association was even larger and more attractive than in previous years, and reflected great credit on those in charge of its arrangement. Among the firms who had space were the following:

Adams & Westlake Co., Chicago, Ill.
American Arch Co., New York, N. Y.
American Balance Valve Co., Jersey Shore, Pa.
American Brake Shoe & Foundry Co., Mahwah, N. J.
American Car & Foundry Co., New York, St. Louis, and Cbicago, Ill.
American Mason Safety Tread Co., Boston, Mass.
American Nut & Bolt Fastener Co., Pittsburg, Pa.
American Steel Foundries Co., Chicago, Ill.
American Vanadium Co., Pittsburg, Pa.
Armstrong Brothers Tool Co., Chicago, Ill.
Baldwin Locomotive Works, Philadelphia, Pa.
Besley & Company, Chas. H., Chicago, Ill.
Bettendorf Axle Co., Davenport, Ia.
Bird & Co., J. A. & W., East Walpole, Mass.
Boyle & Co., Inc., Jno., New York, N. Y.
Bowser & Company, Inc., S. F., Fort Wayne, Ind.
Brill Company, J. G., Philadelphia, Pa.
Brown Auto Hose Coupling Co., Cleveland, O.
Buckeye Steel Castings Co., Columbus, O.
Buffalo Brake Beam C., New York, N. Y.
Burroughs Adding & Listing Machine Co., Detroit, Mich.
Butler Draw Bar Attachment Co., Cleveland, O.
Carborundum Company, Niagara Falls, N. Y.
Carnegie Steel Company, Pittsburg, Pa.
Carter Iron Co., Pittsburg, Pa.
Celfor Tool Co., Chicago, Ill.
Central Electric Co., Chicago, Ill.
Chase & Company, L. C., Boston, Mass.
Chicago Car Heating Co., Chicago, Ill.
Chicago Railway Equipment Co., Chicago, Ill.
Chicago Steel Car Co., Chicago, Ill.
Chicago Varnish Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Car Specialty Co., Cleveland, O.
Clow & Sons, James B., Chicago, Ill.
Coe Brass Mfg. Co., Ansonia, Conn.
Commercial Acetylene Co., New York, N. Y.
Commonwealth Steel Co., St. Louis, Mo.
Consolidated Car Heating Co., Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Co., New York, N. Y.
Cooper-Hewitt Electric Co., New York, N. Y.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Curtain Supply Co., Chicago, Ill.
Damascus Brake Beam Co., Cleveland, O.
Davis-Bournonville Co., New York, N. Y.
Dearborn Drug & Chemical Works, Chicago, Ill.
D. P. Company, New York, N. Y.
Detroit Hoist & Macb. Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Dickinson, Paul, Incorporated, Chicago, Ill.
Dixon Crucible Company, Joseph, Jersey City, N. J.
Dressel Lamp Works, New York, N. Y.
Duff Manufacturing Co., Pittsburgh, Pa.
Duntley Manufacturing Co., Chicago, Ill.
Edison Storage Battery Co., New York, N. Y.
Edwards Company, O. M., Syracuse, N. Y.
Electric Hose & Rubber Co., Wilmington, Del.
Electric Storage Battery Co., Philadelphia, Pa.
Faessler Mfg. Co., J., Moberly, Mo.
Fairbanks Company, New York, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Flannery Bolt Co., Pittsburg, Pa.
Forsyth Brothers Co., Chicago, Ill.
Foster, Walter H., New York, N. Y.
Franklin Manufacturing Co., Franklin, Pa.
Franklin Railway Supply Co., New York, N. Y.
Frost Railway Supply Co., Detroit, Mich.
Galena Signal Oil Co., Franklin, Pa.
Garlock Packing Co., Palmyra, N. Y.
General Electric Co., Schenectady, N. Y.
General Railway Supply Co., Chicago, Ill.
Gilbert & Barker Mfg. Co., Springfield, Mass.
Gold Car Heating & Lighting Co., New York, N. Y.
Goldschmidt Thermit Co., New York, N. Y.
Gould Coupler Co., New York, N. Y.
Greene, Tweed & Co., New York, N. Y.
Grip Nut Co., Chicago, Ill.
Hale & Kilburn Mfg. Co., Philadelphia, Pa.
Hammett, H. G., Troy, N. Y.
Harlan & Hollingsworth Corporation, Wilmington, Del.
Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa.
Heywood Bros. & Wakefield Co., Philadelphia, Pa.
Hobart Allfree Co., Chicago, Iii.
Hunt-Spiller Manufacturing Corporation, South Boston, Mass.
Hutchins Car Roofing Co., Detroit, Mich.
International Correspondence Schools, Scranton, Pa.
Independent Pneumatic Tool Co., Chicago, Ill.
Jenkins Brothers, New York, N. Y.
Johns-Manville Co., H. W., New York, N. Y.
Joliet Railway Supply Co., Joliet, Ill.
Joyce Cridland Co., Dayton, O.
Kelly-Arnold Mfg. Co., Wilkes-Barre, Pa.
Kerite Insulated Wire & Cable Co., New York, N. Y.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Lackawanna Steel Co., New York, N. Y.
Landis Machine Company, Waynesboro, Pa.
Landis Tool Co., Waynesboro, Pa.
Linde Air Products Co., Buffalo, N. Y.
Love Brake Shoe Co., Chicago, Ill.
Lunkenheimer Company, Cincinnati, O.
Lupton's Sons Co., David, Philadelphia, Pa.
McConway & Torley Co., Pittsburg, Pa.
McCord & Company, Chicago, Ill.
Manning, Maxwell & Moore, New York, N. Y.
Midvale Steel Co., Philadelphia, Pa.
Millburn Co., Alexander, Baltimore, Md.
Modoc Soap Co., Philadelphia, Pa.
Molleson Co., Geo. E., New York, N. Y.
Moran Flexible Steam Joint Co., Louisville, Ky.
Nathan Mfg. Co., New York, N. Y.
National-Acme Mfg. Co., Cleveland, O.
National Lock Washer Co., Newark, N. J.
National Malleable Casting Co., Cleveland, O.
National Railway Devices Co., Chicago, Ill.
Newhall Engineering Co., Geo. M., Philadelphia, Pa.
New York Air Brake Co., New York, N. Y.
Nichols & Brother, Geo. P., Chicago, Ill.
Niles-Bement-Pond Co., New York, N. Y.
Norton Company, Worcester, Mass.
Norton, Inc., A. O., Boston, Mass.
Okonite Co., New York, N. Y.
Pantasote Co., New York, N. Y.
Parkesburg Iron Company, Parkesburg, Pa.
Pilliod Brothers, Toledo, O.
Pilliod Company, Swanton, O.
Pittsburg Equipment Co., Pittsburg, Pa.
Pressed Steel Car Co., Pittsburg, Pa.
Pugh, Job T., Philadelphia, Pa.
Railway Materials Co., Chicago, Ill.
Rapp Company, John W., New York, N. Y.
Restein Company, Clement, Philadelphia, Pa.
Revolute Machine Co., New York, N. Y.
Rockwell Furnace Co., New York, N. Y.
Royersford Foundry & Machine Co., Inc., Royersford, Pa.
Safety Car Heating & Lighting Co., New York, N. Y.
Scullin-Gallagher Iron & Steel Co., St. Louis, Mo.
Scully Steel & Iron Co., Chicago, Ill.
Sellers & Company, Wm., Incorporated, Philadelphia, Pa.
Spencer Turbine Cleaner Co., Hartford, Conn.
Sprague Electric Co., New York, N. Y.
Standard Coupler Co., New York, N. Y.
Standard Steel Car Co., New York, N. Y.
Standard Steel Works Co., Philadelphia, Pa.
Stoever Foundry & Mfg. Co., New York, N. Y.
Storrs Mica Co., Owego, N. Y.
Strong, Carlisle, Hammond Co., Cleveland, O.
Symington Co., T. H., Baltimore, Md.
Talmage Mfg. Co., Cleveland, O.
Taylor Mfg. Co., James L., Bloomfield, N. J.
Templeton Kenly & Co., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Titan Steel Castings Co., Newark, N. J.
Toledo Pipe Threading Machine Co., Toledo, O.
Trenton Malleable Iron Co., Trenton, N. J.
Underwood & Co., H .B., Philadelphia, Pa.
Union Draft Gear Co., Chicago, Ill.
Union Fibre Co., Winona, Minn.
Union Mfg. Co., New Britain, Conn.
Union Spring & Mfg. Co., Pittsburg, Pa.
U. S. Metal & Mfg. Co., New York, N. Y.
U. S. Metallic Packing Co., Philadelphia, Pa.
Vanadium Metals Co., Pittsburg, Pa.
Walworth Mfg. Co., Boston, Mass.
Ward Equipment Co., New York, N. Y.
Watson-Stillman Co., New York, N. Y.
Waugh Draft Gear Co., Chicago, Ill.
Welsbach Company, Gloucester, N. J.
West Disinfecting Co., Inc., New York, N. Y.
Western Railway Equipment Co., St. Louis, Mo.
Westinghouse Air-Brake Co., Pittsburg, Pa.
Westinghouse Automatic Air & Steam Coupler Co., St. Louis, Mo.
Westinghouse Electric Mfg. Co., Pittsburg, Pa.
Westinghouse Machine Co., The, Pittsburg, Pa.
Wheel Truing Brake Shoe Co., Detroit, Mich.
Whipple Supply Co., New York, N. Y.
Williams & Co., J. H., Brooklyn, N. Y.
Wood, Guilford S., Chicago, Ill.
Wright Wrench Mfg. Co., Canton, O.
Yale & Towne Mfg. Co., New York, N. Y.

BOOK NOTES.

Correction.—"The Practice and Theory of the Injector," by Kneass, $1.50, which appeared in this column in the last issue, was through error entitled: "Practice and Theory of the Indicator."

Polytechnic Engineer, May, 1910. 144 pages. Cloth. Published annually by the Polytechnic Institute of Brooklyn, 85 Livingston street, Brooklyn, N. Y. Subscription price, $1.50 per copy.

The aim of this book has been to present essentially a Polytechnic publication that will be of interest and value to the undergraduates and their friends in the scientific world and most of the articles are by Polytechnic Institute men. Some very good research work has been presented in permanent form; some of the articles are: Negative Track Feeders, Experiments on the Case-Hardening of Steel by Gases, Train Resistance Formulas and Speed-Time Relations, Gyration Stresses in Shafts, and Some Neglected Branches of Engineering, which is by G. M. Basford.

Metal Spinning. By C. Tuells and Wm. A. Painter. 38 page pamphlet, 6 x 9 in. Illustrated. Published by the Industrial Press, 49 Lafayette street, New York. Price, 25 cents.

This booklet is No. 57 of "Machinery's" Reference Series, and contains some interesting and valuable information for metal workers.

PERSONALS.

J. D. Maupin, general foreman of the Trinity & Brazos Valley Railway at Teague, Tex., has been appointed master mechanic.

Geo. S. McKee, superintendent of motive power and car equipment on the Mobile & Ohio Railroad, retired June 1.

George S. Goodwin has been appointed assistant mechanical engineer of the Chicago, Rock Island & Pacific Railway, with office at Silvis, Ill.

E. J. Robertson has been appointed superintendent car department of the Minneapolis, St. Paul & Sault Ste. Marie Railway, succeeding I. G. Pool, deceased.

H. H. Hillberry has been appointed master mechanic on the Toledo division of the Pennsylvania Lines west of Pittsburgh, at Toledo, O., succeeding Mr. McDonnell, transferred.

George H. Burton, assistant master mechanic of the Northern Central Railway, has been transferred to Renovo, Pa., as a result of the abandonment of the shops at Mt. Vernon.

W. F. Kapp, superintendent of shops and machinery of the Richmond, Fredericksburg & Potomac R. R., at Richmond, Va, has had his title changed to superintendent of motive power.

C. H. Kadie, master mechanic of the Southern Railway at Charleston, S. C., has been transferred to Alexandria with the same title, succeeding Mr. Sasser, transferred.

G. E. Sisco, foreman of the Allegheny shops on the northwest system of the Pennsylvania Lines west of Pittsburgh, has been promoted to assistant master mechanic at Allegheny, succeeding Mr. Hillberry, promoted.

F. V. McDonnell, master mechanic of the Pennsylvania Lines west of Pittsburgh, at Toledo, O., has been transferred to Mahoningtown, Pa., with the same title, succeeding Mr. Reese, promoted.

E. C. Sasser, master mechanic of the Southern Railway at Alexandria, Va., has been appointed master mechanic at Spencer, N. C., succeeding W. F. Kaderly, resigned to go to another company.

M. Flanagan, foreman of the machine department of the Chesapeake & Ohio Railroad at Richmond, Va., has been appointed master mechanic of the Richmond division, with office at Richmond.

W. V. Fountain, master mechanic for the Shreveport, Houston & Gulf R. R., has resigned to accept service in a similar capacity with the Nacogdoches & Southeastern R. R., with headquarters at Nacogdoches, Tex.

O. P. Reese, master mechanic of the Pennsylvania Lines at Mahoningtown, Pa., has been promoted to assistant engineer of motive power on the Northwest system of the Pennsylvania Lines, at Ft. Wayne, Ind., succeeding T. R .Cook, transferred.

Ben Johnson has been appointed superintendent of motive power of the United Railways of Havana and of the Havana Central Railroad with office at Havana, Cuba, succeeding Mr. Charles J. Thornton, resigned.

I. G. Pool, for twenty-two years an employee of the Minneapolis, St. Paul & Sault St. Marie Railway, and for the last few years superintendent of the car department, died at his home in Minneapolis on June 6, aged 66 years.

T. R. Cook, assistant motive power engineer at Ft. Wayne, Ind., has been appointed master mechanic on the Pittsburgh and Cleveland division of the Pennsylvania Lines west of Pittsburgh, at Wellsville, Ohio, succeeding A. C. Davis, resigned.

H. S. Needham, motive power inspector at Columbus, O., has been appointed assistant engineer of motive power on the southwest system of the Pennsylvania Lines west of Pittsburgh, at the same place, succeeding C. D. Young, transferred.

D. Kavanaugh, district storekeeper of the Chicago, Rock Island & Pacific Railway at Silvis, Ill., has been appointed general storekeeper of that railway at the same place, succeeding Mr. Reed, promoted to another department.

William A. Summerhays, assistant general storekeeper of the Illinois Central Railroad at Chicago, has been appointed general storekeeper of that company, the Indianapolis Southern Railroad and the Yazoo & Mississippi Valley Railroad, with office at Chicago, succeeding John M. Taylor, resigned.

C. D. Young, assistant engineer of motive power on the southwest system of the Pennsylvania Lines west of Pittsburgh, at Columbus, O., has been promoted to assistant engineer in the office of the general superintendent of motive power of the lines west of Pittsburgh, at Pittsburgh, Pa.

A. R. Ayers, whose appointment as mechanical engineer of the Lake Shore & Michigan Southern was recently announced in these columns, has been appointed also mechanical engineer of the Chicago, Indiana & Southern Railroad and the Indiana Harbor Belt Railroad.

E. J. Searles has been appointed assistant to J. D. Harris, general superintendent of motive power of the Baltimore & Ohio Railroad, with office at Baltimore, Md. Mr. Searles was engineer of motive power of the Baltimore & Ohio at Pittsburgh from 1902 to 1904, and since 1904 he has been engaged in the railway supply business.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Boiler Tube Cleaner.—The William B. Pierce Co., 327 Washington St., Buffalo, N. Y., is issuing a pamphlet on the Dean boiler tube cleaner, showing why users are enthusiastic.

Air Compressors.—The Ingersoll-Rand Co., 11 Broadway, New York, has recently sent out new catalogues describing class "O C" duplex Corliss steam driven and class "O" duplex steam driven compressors.

Tate Flexible Staybolts.—The Flannery Bolt Co., Pittsburg, Pa., has sent out a very attractive catalog for 1910, describing and illustrating the Tate flexible staybolts and all tools required for their installation.

Gas and Gasoline Engines.—The Turner-Frick Mfg. Co., Sharon, Pa., are sending out an illustrated catalog describing its four-cycle vertical three-cylinder gas engines for power plant work up to 325 h.p. capacity.

Snow Plows.—A very well illustrated catalog for 1910, describing the Russell snow plow and flangers for steam railroads, has been issued by the Russell Car and Snow Plow Co., Ridgeway, Pa.

Fibre Conduit.—H. W. Johns-Manville Co., 100 William street, New York City, has sent out a small booklet describing the J. M. fibre, moulded conduit furnished in sections 54 in. long and ranging from 2 to 4 in. in diameter.

Portland Cement.—The Alpha Portland Cement Co., Easton, Pa., is issuing a very attractive catalog descriptive of its product, which includes some excellent examples of recent concrete work, both for railroads or industrial and municipal concerns.

Machine Tools.—A new catalog has recently been issued by the Murchey Machine & Tool Co., Detroit, Mich., which illustrates and describes a number of machines and tools for rapid machine work, including the latest automatic nipple machines, automatic dies and revolving, fitting and valve chucks.

Gas Analysis Instruments.—The Carb-Ox Co., Rogers Park, Chicago, has recently issued a new catalog describing gas analysis instruments, appliances used for boiler testing and other specialties. This apparatus is suitable for power plants using coal, oil, gas or any other fuel.

Lifting Magnets.—A very interesting little circular has recently been issued by the Cutler-Hammer Clutch Co., Milwaukee, Wis., which shows a large and clear sectional view of a new lifting magnet, with a good description; and also other views showing the application to all classes of work.

Bartley Nut and Bolt Fasteners.—Catalog No. 6 bearing the above title has recently been issued by the American Nut and Bolt Fastener Co., Pittsburg, Pa. It illustrates the application of all the various forms of fasteners and nut locks and includes a complete price list.

Coal Crushers.—A very clearly and attractively illustrated Bulletin No. 39 is being sent out by the Jeffrey Mfg. Co., Columbus, Ohio, describing in detail their coal and coke crushers and giving complete tables of dimensions and capacities. The crusher rolls are made up of renewable sections.

Ball Bearings for Car Journals.—The Hess-Bright Mfg. Co., Philadelphia, Pa., has just issued an interesting circular describing and illustrating by means of a sectional view a correct application of ball bearings to car journals.

Grinding Machines.—A very attractive catalog has recently been issued by the Landis Tool Co., Waynesboro, Pa., describing a variety of grinding machines for all classes of work. It is completely illustrated and includes sectional views with dimensions for all their various shapes and sizes of grinding wheel carried in stock.

Curtis Turbine Installations.—An attractive catalog, No. 4732, has recently been issued by the General Electric Co., Schenectady, N. Y., bearing the above title and containing upwards of fifty illustrations of installations of Curtis steam turbine generators from 25 kw. up to 12,000 kw. Power plant managers will find this very interesting.

Friction Draft Gear.—The Union Draft Gear Co., Monadnock Block, Chicago, has recently issued a new catalog illustrating the Cardwell friction draft gear. This catalog is very well illustrated and includes the results of a number of tests of this draft gear.

Work Done.—Westinghouse, Church, Kerr & Co., engineers and constructors, 10 Bridge St., New York City, have issued a very nicely illustrated catalog with the above title, containing 82 pages and describing the entire range of engineering and construction service which they have completed. This work includes contracts in every part of the United States, Southern Canada and Mexico, in connection with railroad terminals, electrical equipment plants, etc.

Electric Hardening Furnace.—The General Electric Co., Schenectady, N. Y., has recently issued Bulletin No. 4737 illustrating and describing its electric hardening furnace for hardening or tempering tool steel. This furnace is very economical and constitutes a marked improvement over all previous methods. The same company has also issued Bulletin No. 4738 describing belt driven revolving armature alternators. Bulletin No. 4736, describing the lightning arresters for alternating and direct current high voltage circuits, will be of interest to central station managers, as well as No. 4741, on luminous arc lamps for direct current multiple circuits.

Electric Fixtures.—A very artistic and attractive catalog of 85 pages, bearing the above title, has recently been issued by the Safety Car Heating and Lighting Co., 2 Rector street, New York. No expense has been spared in illustrating the design of these fixtures, as well as the character of the workmanship, which the company uniformly insists upon. It has been the aim also to show a comprehensive collection from the great variety of designs representing all the principal schools of art. Special attention is given to the photometric tests and the designs are worked out in every case to insure an interchangeability of parts.

Locomotive Valve Gear.—A new 28-page illustrated catalog has recently been issued by the Hobart-Allfree Company, 1380 Old Colony Building, Chicago, Ill., which describes its locomotive cylinders and new design of valve gear. This new gear is the radial type, located entirely outside of the locomotive frames and does not require links. It incorporates an auxiliary exhaust valve in the cylinders, controlling the point of compression, which is said to greatly improve the steam distribution.

NOTES.

Wisconsin Engine Company.—The above company announces that George B. Foster has been appointed its Chicago sales manager, with offices in the Fisher Building, Chicago.

Triumph Electric Co.—The healthy condition of the electric trade is well indicated by the announcement from the above company, of Cincinnati, O., that during the past few weeks they have sold an unusually large number of large size machines, as well as a normal amount of smaller equipment. They report business to be excellent in every department.

Reliance Electric & Engineering Company.—The above company, of Cleveland, Ohio, announces that hereafter its armature shifting type of variable speed motor will be known as the Reliance Adjustable Speed Motor instead of the Lincoln Variable Speed Motor as formerly, to comply with present standard terms adopted by the American Association of Electric Motor Manufacturers and also to avoid confusion with the Lincoln Electric Company of the same city.

Joseph Dixon Crucible Company.—It is announced that at the annual meeting of the stockholders of this company, the old board, consisting of Geo. T. Smith, William Murray, William H. Corbin, Edward L. Young, Geo. E. Long, William H. Bumsted and Harry Dailey, were unanimously re-elected, and the board of directors re-elected the former officers, namely, Geo. T. Smith, president; William H. Corbin, vice-president; Geo. E. Long, treasurer; Harry Dailey, secretary; J. H. Schermerhorn, assistant treasurer and assistant secretary. William H. Corbin was also re-elected as counsel.

Lucius I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Co., 11 Broadway, New York, announces that he has resigned his position, effective August 1st, and that he will open an office in New York City as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products. To his long experience in managing one of the largest advertising accounts and publicity departments in the machinery field, he joins a prior experience of years in practical mechanical and electrical engineering, construction work, and machine design and manufacture.

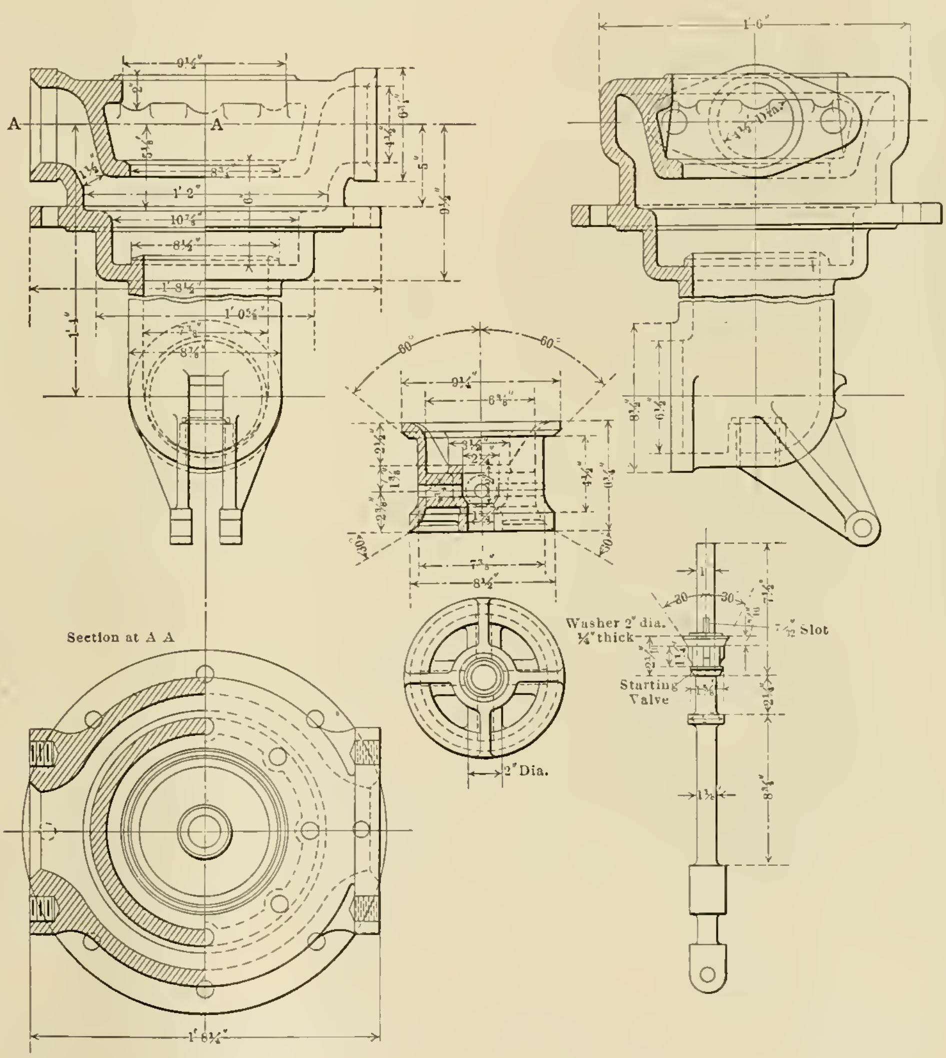
The Bettendorf Axle Co.—Wm. P. Bettendorf, president of the above company, Davenport, Iowa, died June 3, at his home, at the age of 53 years, as the result of cancer of the bowels. Mr. Bettendorf was generally recognized by those who knew him in his work as a man of remarkable inventive and mechanical ability. His inventions were marked by great originality, and have established merit. His methods of manufacture contributed hardly less to this success than the mechanical design of the articles themselves. The successful building up of a great railway industry at a point so remote from the producing centers of the material used, shows that business ability was combined with that of inventor and designer. His first railway device was a pressed-steel brake beam, of which but few were manufactured. He next turned his attention to I-beam bolsters and underframing for cars. Still later he invented the cast steel side frame for trucks, in which the journal boxes and frame are cast integrally in one piece. The success of his business is too recent to need to have attention called to it.

SOME DETAILS OF THE ARTICULATED COMPOUND LOCOMOTIVE BUILT AT THE SHOPS OF THE CANADIAN PACIFIC RAILWAY.

On page 81 of the March, 1910, issue of this journal appeared a very complete and interesting description of the experimental Mallet locomotive recently built at the Angus shops of the Canadian Pacific Railway. That article considered the essential features of the design and gave the results of the tests made on it, also mentioning briefly a number of the more interesting details. The design of many of these features is entirely original and in some cases unique, and we are now able to give illustrations of a number of the more prominent ones.

THROTTLE VALVE.

Reference to the boiler drawing on page 82 will show that the



THROTTLE VALVE WITH SMALL AUXILIARY STARTING VALVE.

throttle valve chamber is secured outside of the boiler shell and connects to a cast iron dry pipe from the dome, located just ahead of it, by means of an interior extension. From the throttle valve chamber the steam is carried to the superheater through two external pipes, one on either side, which are very heavily lagged to reduce condensation.

This chamber is of cast iron and rests on a brass ball ring having a ground joint with the plate secured to the boiler shell. the pressure so that when the main valve is opened there is not a

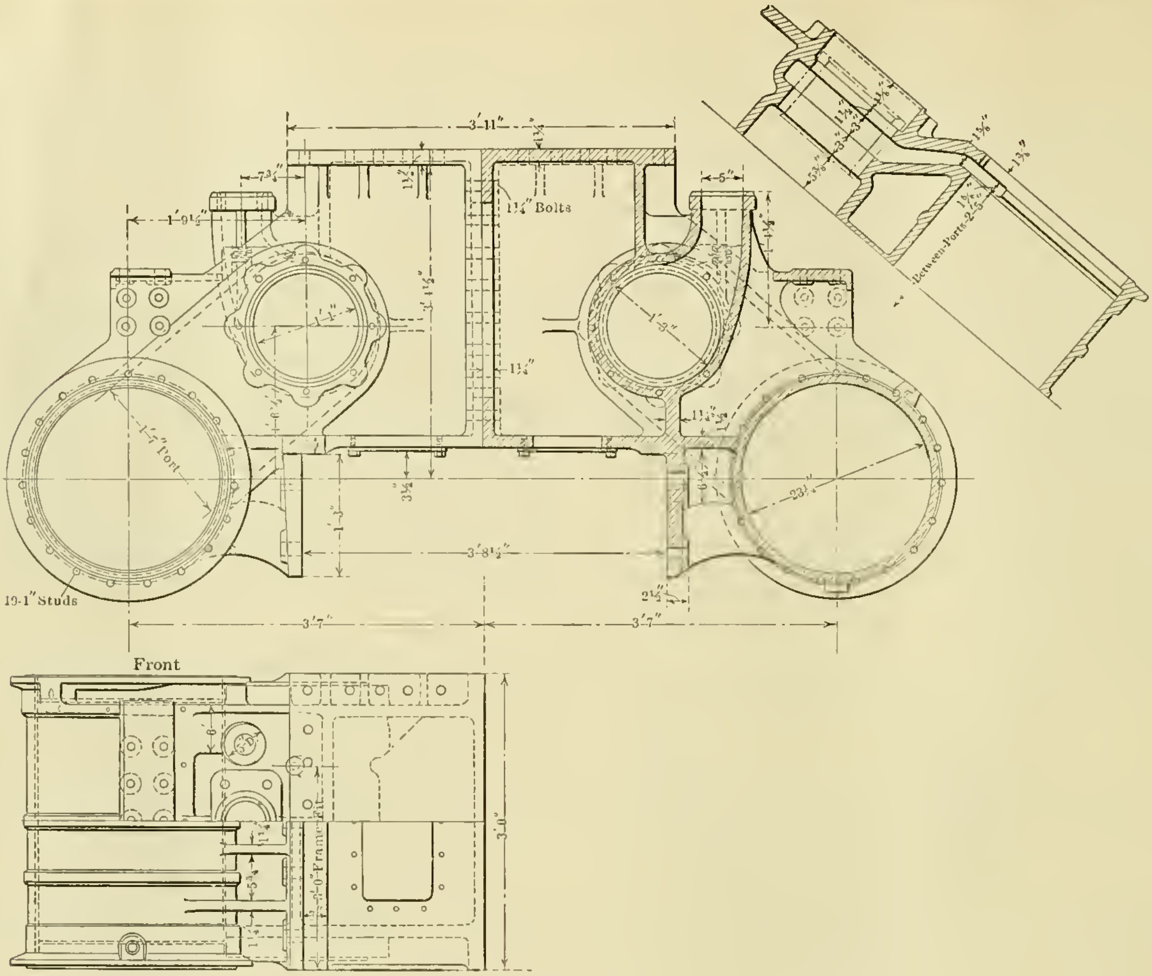
The throttle valve proper is, of course, of the balanced type, there being a large steam chamber above it, admission to which is obtained through the hollow center of the valve. It is 9¼ in. in diameter at the top and 8½ in. at the bottom. A starting valve arrangement is included consisting of a small valve secured to the stem which seats in the center of the main valve when the throttle is closed. The main throttle is not fastened to the stem but is lifted by a lug or boss which comes in contact with the bottom of the main valve. Before this occurs, however, the small starting valve is lifted ½ in. and gives an admission through four ¾ in. ports in the body of the main valve. These serve to fill the steam pipes, superheater, etc., and to some extent equalize

sudden large draft of steam.

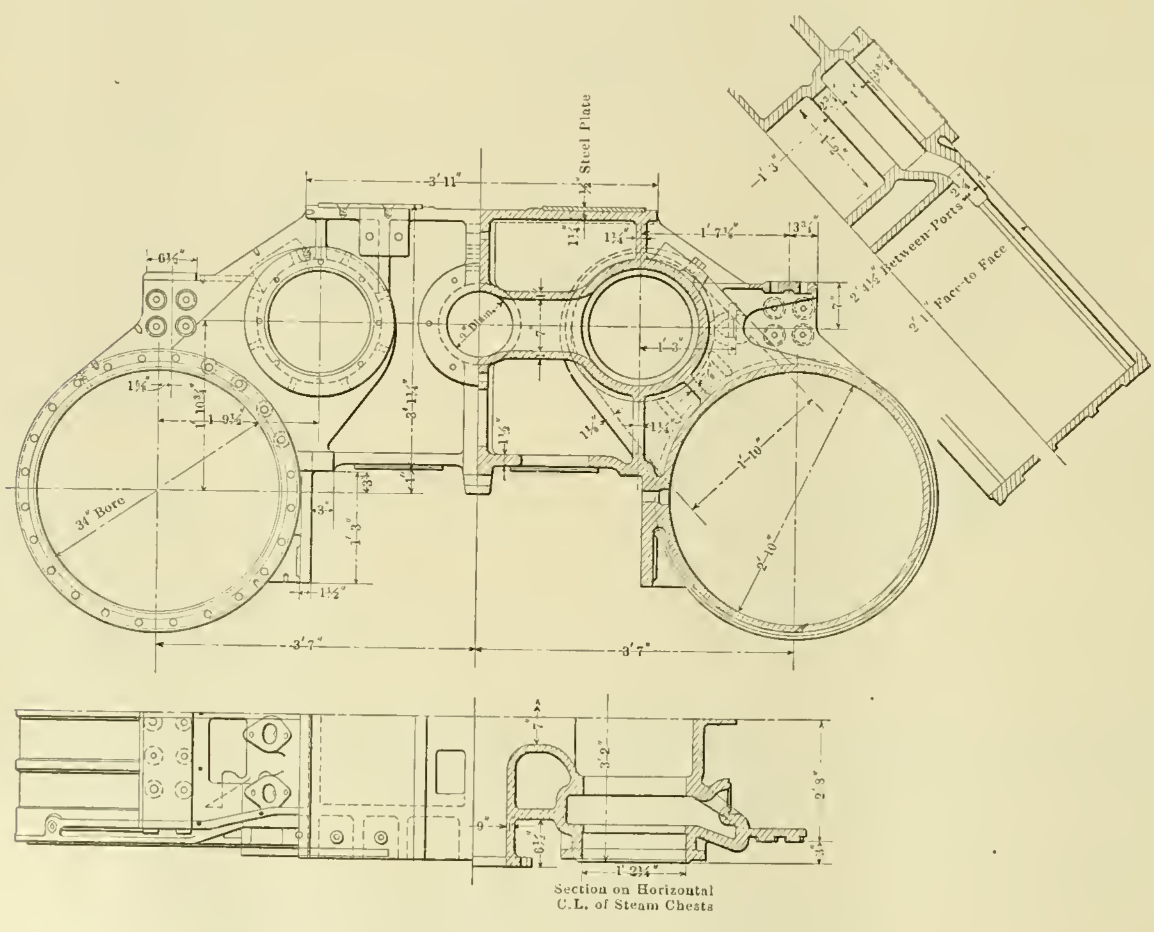
Reference to the illustration will show the detail construction of these parts and also the arrangement for the bell crank, which is connected to the throttle lever in the cab.

CYLINDERS.

Both sets of cylinders are cast independent of the saddle proper but are joined on the center line in the usual manner. Piston valves are used, the high pressure being inside admission and the

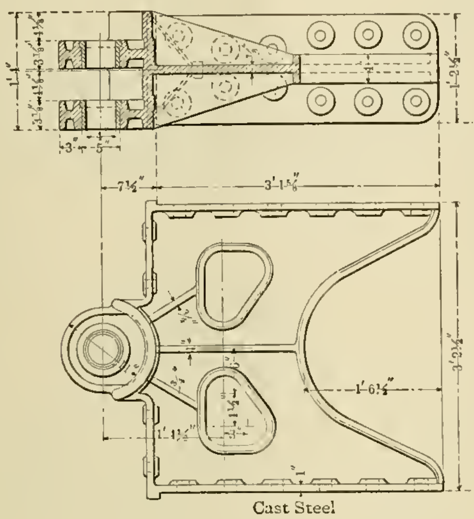


HIGH PRESSURE CYLINDERS—CANADIAN PACIFIC MALLET.



LOW PRESSURE CYLINDERS—CANADIAN PACIFIC MALLET.

low pressure outside. The design of both of these cylinders is clearly shown in the illustration and follow, as far as possible, the standard arrangement of this road. The valve chambers are set inside over the frames, the valves being operated by a rocker, the same as on simple engines on this road. A steam pipe from the superheater extends down outside of the boiler and connects to an extension from the top of the valve chest of the high-

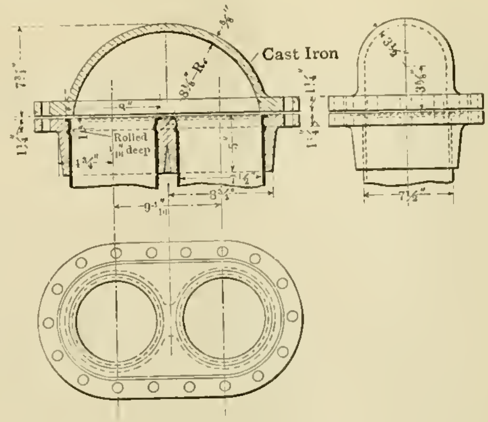


HINGE CASTING.

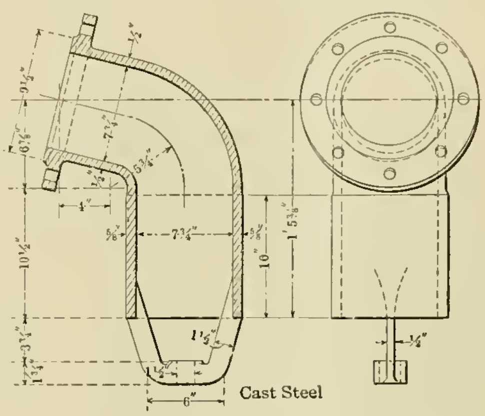
pressure cylinders. The exhaust is all through the front head of the valve chamber, the piston valves being of the hollow type. A cast steel saddle secures the high-pressure cylinders to the boiler. Inasmuch as this connection is made to a point on the barrel which is under pressure, great care was used to prevent any possibility of the bolts working loose. The saddle is secured to the barrel by 1¼ in. bolts driven into taper holes reamed from the pressure side. The connection to the cylinders is on a flat surface 3 ft. 11 in. wide by 3 ft. long and is made by 32 1⅛ in. bolts.

There is, of course, no connection between the boiler and the low-pressure cylinders, although a small saddle or steadying casting is secured to the barrel at this point and slides on a steel plate on the top of the cylinders. This, however, is not expected to carry any weight.

The relative arrangement of the valve chambers and cylinders is the same as on the high pressure but the exhaust passage is



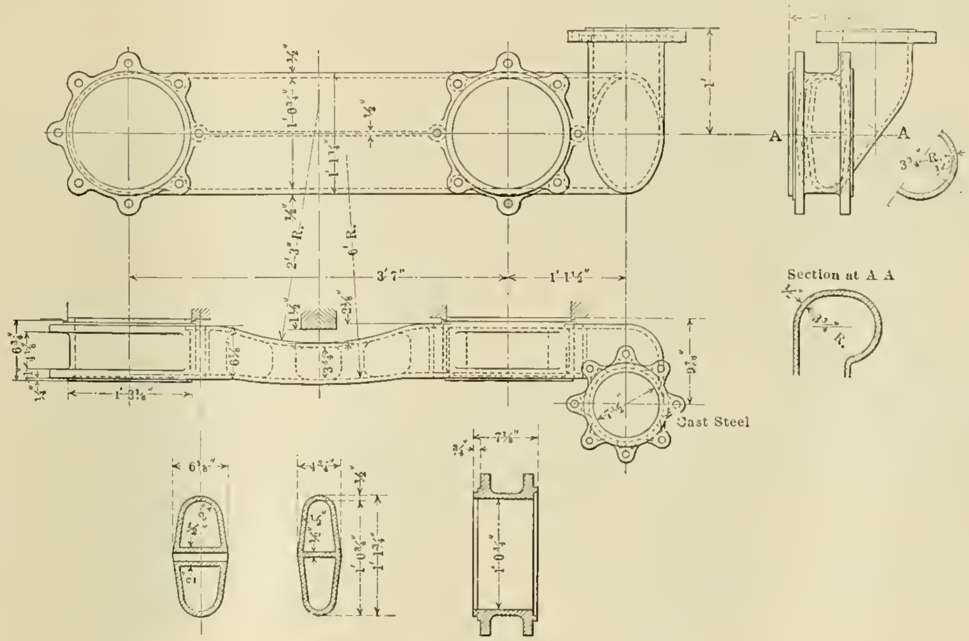
RETURN BEND ON RECEIVER PIPE.



SWIVEL ELBOW IN RECEIVER LINE.

carried from the center of the steam chest to a 9 in. opening in the center of the cylinder casting on a line with the valve chambers. This passage is closed by a plate at the rear and continued by an elbow at the front to the exhaust pipe.

A study of the design of these cylinders will show the care that has been used to secure lightness and simplicity. At first sight it might appear that the flanges for the frame connections were too light but when it is remembered that the frames are slabbed to 15 in. in depth by 3 in. wide at this point and the hinge or articulated joint castings which connect the two groups together



RECEIVER HEADER ON HIGH PRESSURE CYLINDERS are secured between the frames below the cylinders, it is evident that this flange is of ample strength.

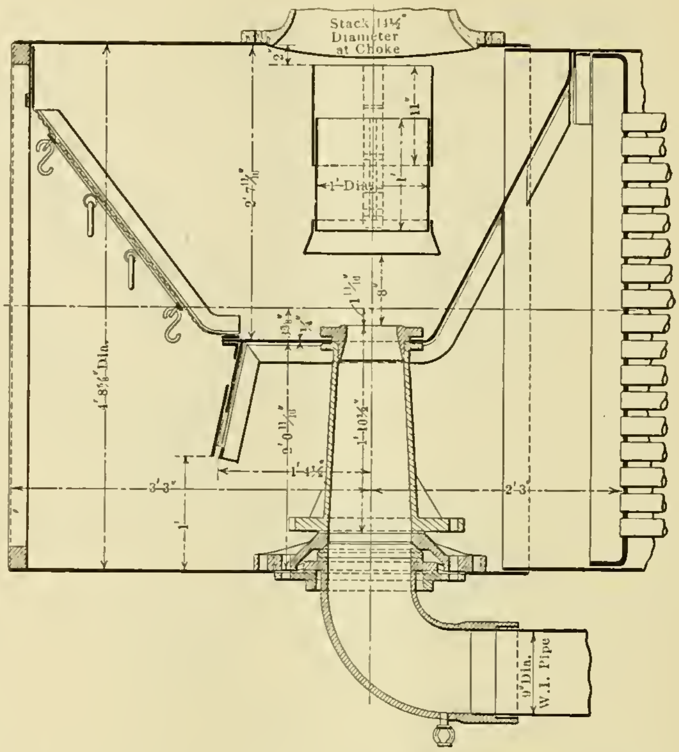
One of the illustrations shows this hinge casting, which is in duplicate for the front and rear groups, simply being reversed in order to get the proper bearings for the lugs.

RECEIVER AND EXHAUST PIPING.

A cast steel header connecting on the front of both valve chambers of the high pressure cylinders carries the exhaust from these cylinders to the receiver pipe located on the left side of the locomotive. One of the illustrations shows the detail of this header. The steam chest heads are secured outside and it really forms part of the cylinder, although, of course, removable, the studs holding the heading being attached directly to the cylinder and passing through the header. The receiver consists of a 7 in. wrought iron pipe extending outward and upward from this header for about 6 ft. It then connects to a return bend and is continued downward and inward to an elbow pipe, located directly over the pin connecting the two groups. At this point there is a packed swivel joint, being the only one on the locomotive. This joint is made between this elbow pipe and the header secured to the rear of the low pressure cylinders, extending from the valve chambers in a manner very similar to the high pressure header.

One of the illustrations shows the detail of this connection. The cast steel elbow pipe has a straight finished surface, its lower end extending down through the gland on the low pressure header. The packing is alternate wedges of cast iron and white metal, there being four pairs in the set. The steam pressure would tend to force the elbow pipe out of the gland and a loop has been cast at its bottom which extends down and swivels around a 1¼ in. bolt in the bottom of the header.

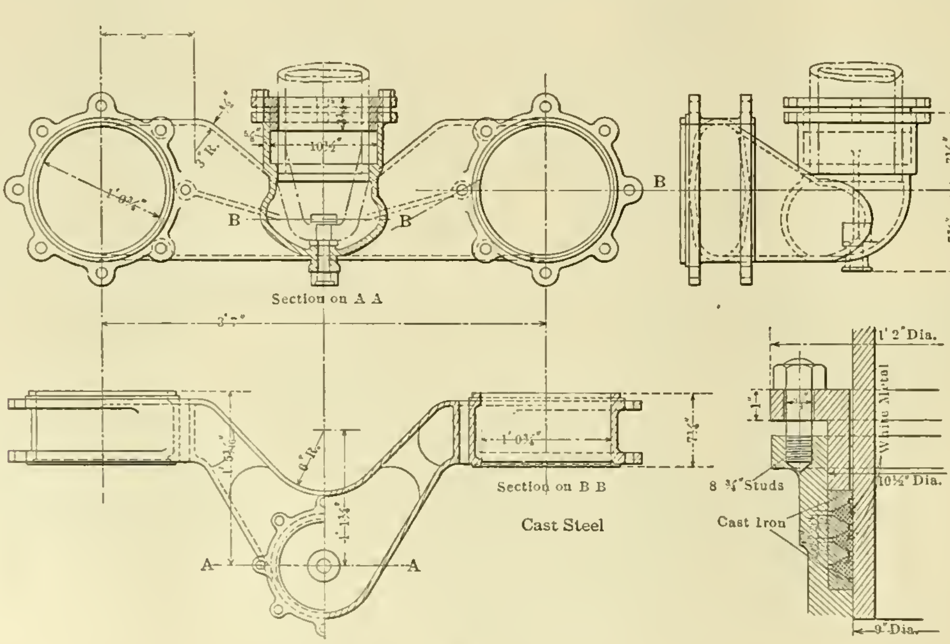
From the exhaust passages in the low pressure cylinders the steam is carried to the exhaust pipe in the front end through a 9 in. pipe arranged with a swivel joint at both ends. The illustration of the front end shows the construction of the joint at that point and the other joint of the same arrangement is formed on top of an elbow pipe that extends out from the exhaust passage in the low-pressure cylinder. Both of these joints are arranged to swivel, having a ball seat, and are also permitted a longitudinal movement to the small extent required by the design,—only ⅜ of an inch. The arrangement consists of a brass ball ring having a ground joint connection on its lower surface, the whole elbow pipe construction being held together by ten springs of 200 lbs. capacity each, or a total of 2,000 lbs. In this manner a slip-joint in the exhaust line was made unnecessary.



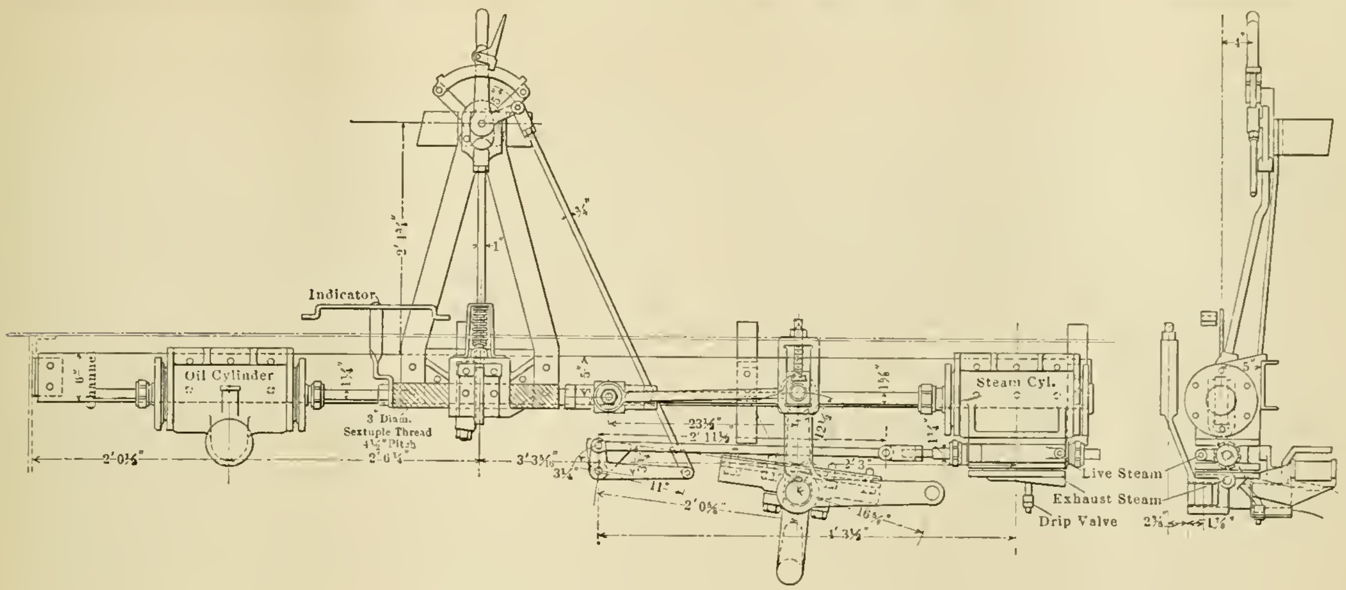
FRONT END ARRANGEMENT SHOWING SWIVEL AND EXPANSION JOINT IN EXHAUST PIPE.

STEAM REVERSE GEAR.

This gear is entirely original in many of its features and in the matter of simplicity, accuracy of adjustment and reliability it has many advantages. A 6 in. steam cylinder controlled by a slide valve in the steam chest below it forms the source of power for operating the reverse mechanism of both sets of gears. The piston rod in this cylinder is connected to a screw with very large pitch, which in turn connect to the piston rod of the oil cylinder, that acts as a dash pot. Just ahead of the screw is a block forming part of the piston rod to which are hinged a double link that connects to the upright arm forged integral with the reverse shaft. To the reverse shaft is also keyed the lifting arm for the high pressure gear, which has a slotted upper end carrying the block to which the reach rod from the low pressure gears extend. In this manner it is possible to adjust the movement of the valve of the low pressure cylinders independent of the high pressure valves, as was explained on page 84 of the March issue.



RECEIVER HEADER ON LOW PRESSURE CYLINDERS



STEAM REVERSE GEAR—CANADIAN PACIFIC MALLET.

The large screw mentioned as forming part of the connection between the oil and steam cylinders is 3 in. in diameter, having a sextuple thread, 4½ in. pitch. On this screw is carried a large nut with a notched ring. This nut is held in place by a frame extending out from the side of the firebox and because of the coarse thread it easily revolces as the gear is moved. The latch from the lever sets into the notches in the ring, preventing its movement and thus locking the gear in any desired place. The lever is carried on a standard at the proper height and connects to the slide valve of the steam cylinder through a bell crank, as is shown in the drawing. The latch at the large nut is so connected that lugs on the reverse lever will lift it whenever the lever is thrown in either direction.

In operation, the small lever is thrown forward, for instance, which movement first unlatches the large nut and then moves the slide valve to the left (referring to the large drawing). This admits steam to the left side of the piston and carries the lift shaft toward the right. When it has moved the desired distance, as shown by the indicator, the operating handle is brought to the center, shutting off the steam and at the same time dropping the latch into the notches on the large nut and holding the whole gear securely.

LINE SHAFT DRIVE AND INDIVIDUAL MOTOR DRIVE IN MACHINE SHOPS.*

A. G. Popcke.

Power for the operation of machine tools may be furnished either by individual motors or from a line shaft. In laying out an installation of machine tools, the relative merits of the different methods of drive should be carefully considered. The first cost of drive from a line shaft is usually less than by individual motors. In a great many cases a line shaft drive has been installed without giving due consideration either to the advantages or the savings which can be effected by an individual motor drive.

The writer has at hand a number of experimental tests from which the following analyses have been obtained. Formerly practically all shops were driven from long line shafts and the speed regulation was very poor. A break-down anywhere in the shop would then shut down the whole system. So simple a thing as a belt leaving its pulley was likely to cause a cessation of work for a considerable length of time. More recently the steam engine has been replaced in many cases by one large motor, thus securing more uniformity in speed regulation. Then came the division of tools into groups with an individual motor for each group. By this method even better speed regulation is obtained and there are fewer general delays.

For most kinds of service, however, the advantage of making each tool independent of others has become evident to close observers. It is found that with individual motors, higher speeds and deeper cuts are possible. The water-hardened steel cutting tools formerly used would not permit this, nor was the structure of the old line-shaft-driven tools strong enough to stand the additional stresses due to heavier cuts. High-speed steel came to meet the first need, and stronger construction soon brought the machine tools in line. To the advent of the electric motor, then, can be ascribed the commercial development of high-speed steel and many improvements in machine tool construction.

Increased economy in the operation of manufacturing machinery can be effected in two ways:

1—By reducing the power required to operate the machinery.

2—By reducing the time required for a given operation, or, in other words, increasing the output in a given time.

When confronted with the problem of deciding between the continued use of an existing line shaft or individual motor drive, or when deciding between the two methods for a new installation, the problem should be impartially considered in all its phases, somewhat as outlined in Table I. This table includes every important item to be considered, except one, and in every case the advantage is with the motor.

Comparative first cost is possibly the first consideration to enter the mind of most men, and this is the one consideration purposely omitted from Table I. That this consideration is of relatively minor importance, is evident when the saving in power consumption and in time made possible by the use of individual motors is considered.

Economy in Power Consumption.

In order to determine the power required to drive line shafting and to obtain data for making accurate estimates, tests have been made by the aid of a graphic recording meter on motor-driven line shafts. The fact that these shafts were motor-driven gave them some advantage over engine-driven shafts, and made accurate measurements possible, otherwise the method of driving the line shaft need not be considered here. In each case the line shaft was belted to short counter-shafts from which the machine tools were driven. In the following discussion all references to the power required to drive the line shaft are understood to include the power requirements of the counter-shafts and connecting belting.

* From the *Electric Journal.*

Test No. 1.—This test was made on a lightly loaded line shaft driving three machine tools, the conditions being as follows:

Length of main shaft, 115 feet.
Diameter of main shaft, 3 inches.
Self-oiling bearings every eight feet; dimensions 3 in. x 12 in.
Couplings every 24 feet.
Driving motor, 40 h. p., 720 r.p.m.
Machine tools—
One 14 ft. boring mill; maximum power requirement... 3 kw.
One 48 in. x 10 ft. planer; maximum power requirement 2 kw.
One 10 ft. x 20 ft. planer; maximum power requirement 3 kw.

Maximum power requirement with all tools working at maximum output .... 8 kw.

The test showed that 4.5 kw. input to the motor was required to drive the line shaft with no machines operating. Tests lasting over several hours showed that the machines while operating under existing shop conditions required an additional average input of only about 1.5 kw.; that is, the total motor input was approximately 6 kw. Of this amount the line shaft required 75 per cent. and the machine tools only 25 per cent., including their friction and power requirements.

The input to the motor, when driving the line shaft alone, was 3.5 kw. Tests of several hours' duration showed an average of 2.1 kw. additional to drive the tools under practical operating conditions. That is, the total average motor input was 5.6 kw., of which the line shafting absorbed 63 per cent. and the machines only 37 per cent.

The annual cost of power, at $0.02 per kilowatt-hour, would be 5.6×2,808×$0.02=$314.50, of which 63 per cent., or $196.56, is chargeable to line shafting and the remainder, $117.94, to the tools. The maximum input to the motor observed during the test was 6.6 kw.; but assuming, as before, a maximum average of one-half full capacity, the machines would require 6.5 kw., making a total average input of 10 kw., of which the line shaft would require 35 per cent. and the tools 65 per cent. The power cost, at $0.02 per kilowatt-hour, would then be 10×2,808×0.02=$561.60 per annum; 35 per cent., or $196.56, being chargeable to the line shaft, and 65 per cent., or $365.04, to the tools.

Test No. 3.—This test was made on a heavily loaded line shaft driving 12 machine tools. The length of the line shaft was 300 feet, all other dimensions of the shaft, bearings and couplings being the same as in test No. 1. The driving motor was 40 horse-power, 720 r.p.m., and the tools consisted of three planers, five boring mills, three radial drills, one slotter and one milling machine.

The input to the motor for the shaft alone was 6.3 kw., and the average additional input for the machine tools was 8.0 kw., making a total average input of 14.3 kw. Of this total the shafting absorbed very nearly 44 per cent. and the tools the remainder, or 56 per cent. The annual cost of power, with the former assumptions, would be 14.3×2,808×0.02=$803.09, of which 44 per cent., or $353.36, is chargeable to the shafting.

If all the tools driven from this line shaft were working simultaneously at full capacity they would require a motor input of 42 kw. The maximum input to the motor observed during the test was 19.4 kw. Assuming, however, maximum practical average operating conditions to be half capacity full time, the machines would require 21 kw., making a total input of 27.3 kw., 23 per cent. being chargeable to the line shaft. The power cost at $0.02 per kilowatt-hour would then be 27.3×2,808×0.02=$1,533.17 per annum, of which $353.36 is chargeable to the line shaft.

Item.	Line Shaft Drive.	Individual Motor Drive.	Advantage of Individual Motor.
1—Power consumption	Constant friction. Loss in shafts, belts and motor. Power for cutting.	Friction loss (motor and tool only) and useful power only while working	Less power required
2—Speed control	No. speeds = No. cone pulleys × No. gear ratios.	No. speeds = No. controller points × No. gear ratios	More speeds possible. Time saved in making speed adjustments
3—Reversing	Clutch and crossed belt.	Reversible controller	Time saved in reversing
4—Adjusting tool and work	Stopping at any definite point very difficult	Can be started in either direction and stopped promptly at any point	Time saved in setting up and lining up a job
5—Speed adjustment	Large speed increments between pulley steps	Small speed increments between controller steps	Time saved in obtaining proper cutting speed
6—Size of cut	Limited by slipping belt Large belts hard to shift	Limited by strength of tool and size of motor	Time saved by taking heavier cuts
7—Time to complete a job			Much less time required as indicated for previous items
8—Liability to accidents	Slipping or breaking belts. Injury to machine tool, cutting tool or prime mover	Injury to machine tool, cutting tool or motor	Much less liability to accidents
9—Checking economy of operations	Close supervision required. Very difficult to locate causes of delay	Accurate tests possible by means of graphic records	Causes of delay and the remedies easily located without personal supervision
10—Flexibility of location	Location determined by shafting, and changes are difficult	Location determined by sequence of operations. Changes readily made.	Greater convenience in handling work and increased economy of operation. More compact arrangement possible

TABLE I—COMPARISON OF LINE SHAFT DRIVE AND INDIVIDUAL MOTOR DRIVE.

Assuming the cost of power at two cents per kilowatt-hour, and that a working year contains 2,808 hours (54 hours per week), the cost of power for the foregoing installation would be 6×2,808×$0.02=$336.96 per annum, of which 75 per cent., or $252.72, is chargeable to the line shaft. This assumption of power cost is low for many installations, especially for small, isolated plants.

While making the foregoing tests the machines were not all operating at full capacity. Assuming the best practical average operating conditions to be full capacity of each tool one-half of the time or one-half capacity full time, the machines would require 4 kw. The total average input to the motor would then be 8.5 kw., of which the line shaft would absorb 53 per cent. and the machine tools 47 per cent. The power cost at two cents per kilowatt-hour under the foregoing assumptions would then be 8.5×2,808×$0.02=$477.36 per annum, of which 53 per cent., or $252.72, is chargeable to the line shaft.

Test No. 2.—This test was made on a moderately loaded line shaft driving five machine tools. The details of the shaft construction were the same as in Test No. 1, and the other conditions were as follows:

Driving motor 30 h. p., 720 r.p.m.
Machine tools—
One 14 ft. vertical boring mill; maximum power requirement .... 3 kw.
One 6 ft. radial drill; maximum power requirement.... 2 kw.
One 7 ft. radial drill; maximum power requirement..... 2 kw.
Two No. 8 Niles horizontal boring, drilling and milling machines; maximum power requirement, each........ 3 kw.

Maximum power requirement with all tools working at maximum capacity ....13 kw.

Economy in Time.

The relative time economy of motor drive and shaft drive is best illustrated by comparing the two methods for a given installation. The overhead charges, consisting of interest, insurance, taxes, repairs to plant, salaries, etc., are practically the same for either method of driving.

For purposes of comparison, the cost of equipping the tools referred to in Test No. 2 with individual motors will be considered, and the saving to be effected thereby estimated. The data used for making the comparison are based either on actual tests or assumptions warranted by experience.

TABLE II—MACHINE TOOLS AND OPERATING COSTS OF TEST NO. 2.

Machine Tool	Operating Costs		Individual Motor	
	Overhead	Wages	HP	Cost Including Controller
14 ft. Vertical Boring Mill.....	$1 50	$0 35	10	$370
5 ft. Radial Drill..........	50	0 30	5	255
7 ft. Radial Drill..........	1 20	0 30	7.5	290
No. 8 Horizontal Boring Mill..	3 00	0 35	5	200
No. 8 Horizontal Boring Mill..	3 00	0 35	5	200
Total Costs........	$9 20	$1 65		$1 315

The overhead cost and wages per year of 2,808 hours (54 hours per week), for either line shaft or motor drive, from Table II, are:

Overhead	2,808 × 9.20 =	$25,833.60
Wages	2,808 × 1.65 =	4,633.20
Total		$30,466.80

The cost of a large motor and line shaft drive for the foregoing installation is approximately $900. The cost of the individual motors is $1,315, as indicated in Table II. Assuming that the cost of attachments, changes in tools to fit them for motor drive, wiring, etc., is the same as the cost of line shaft drive, $900, the total cost of the individual motor installation is $1,315+$900=$2,215.

The cost of power for line shaft drive, as determined from Test No. 2, is $314.50 per year, with power at two cents per kilowatt-hour, of which $117.94 is chargeable to the tools. In some cases the installation of individual motors has resulted in more than 20 per cent. increased output, but assuming a conservative estimate, ten per cent., the power cost can safely be placed at $130 per year. Calculating interest on the cost of the machine tool at six per cent. and depreciation at ten per cent., the operating costs can be compared as follows:

	Line Shaft.	Indiv. Motors.
Overhead and wages..........................	$30,466.80	$30,466.80
Interest and Depreciation @ 16% on costs of installation, $900 and $2,215, respectively.....	144.00	354.40
Power	314.50	130.00
Total	$30,925.30	$30,951.20

This comparison shows a balance in operating costs of $30,951.20—$30,925.30=$25.90, favoring the line shaft drive. Experience has shown, however, that tools equipped with individual motors will turn out at least ten per cent. more finished product than they will when line-shaft-driven. Assuming that the earnings of the shaft-driven tools are just equivalent to their operating costs, an increase of ten per cent. in output makes $0.10× $30,925.30=$3,092.53 increased earnings per year obtainable by the use of individual motors with scarcely any increase in arrangement for driving a shop in any given case.

With the asssumed maximum practical operating conditions given under Test No. 2, the power cost for line shaft drive is $561.60, $365.04 being chargeable to the tools. Assuming ten per cent. increased output with individual motor drive, the cost of power would be about $400. The comparison of line shaft drive and individual motor drive would then be as follows:

	Line Shaft.	Indiv. Motors.
Overhead and wages..........................	$30,466.80	$30,466.80
Interest and depreciation..........................	144.00	354.40
Power	561.60	400.00
Total	$31,172.40	$31,221.20

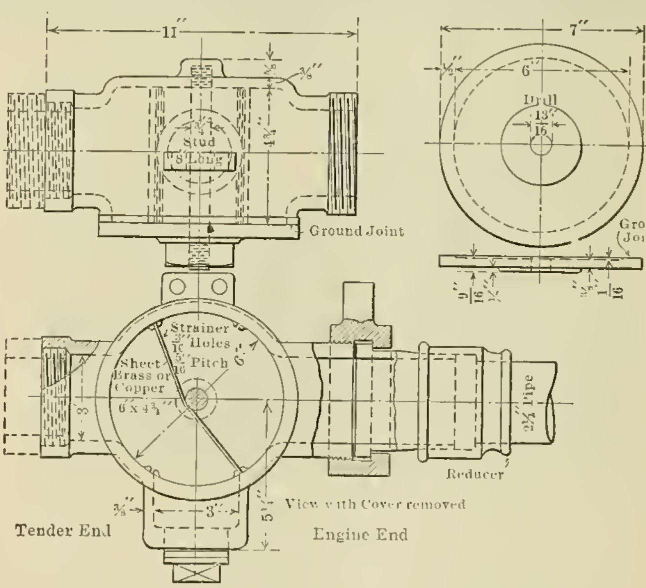
This assumption leaves a balance of $48.80 favoring line shaft drive, provided the increased output with motors be not considered. When allowance is made for ten per cent. increased output, the comparison shows $3,117.24—$48.80=$3,068.44 per year favoring individual motor drive.

The foregoing analyses show that the only consideration favoring line shaft drive—namely, lower first cost—is much more than overbalanced by the increased production possible with motor drive; also, that the cost of power, though in favor of motor drive, plays a very small part in the determination of operating expenses in a machine shop. It is to be noted also that the higher the cost of power the more favorable the proposition becomes to individual motor drive.

The foregoing shows that the question of whether or not to use individual motor drive in any particular case is a financial one and must be properly analyzed. The best way for a shop manager to solve this problem is to be guided by the following question: What investment shall I make and how shall I equip my shop so as to obtain the greatest income upon the investment? Individual drive means an increase in investment, but in nearly all cases a much greater percentage income will be reaped than if line shaft drive was employed. The above discussion shows in a general way how to determine the best expense, leaving a net annual profit of approximately $3,092.53—$25.90=$3,066.63, favoring the motor drive.

TANK STRAINER.

In the design of tank strainer shown in the illustration, the connection to the tender is from the left and a copper screen is set at such an angle and location that the flow will force any solid particles larger than the perforations off from the screen and into the receptacle below. At the same time the screen is practically vertical across the flow of the water and thus offers the least obstruction. It is accessible for cleaning by the removal of a single nut, which releases the head having a ground



joint with the body of the valve. The removal of a plug at the bottom not only permits the flushing of the strainer but also drains all connections between the tank valve and the injector.

This strainer is very simple in its arrangement and construction and was designed in the mechanical engineer's office of the Illinois Central Railroad, where it is being put into very extensive use.

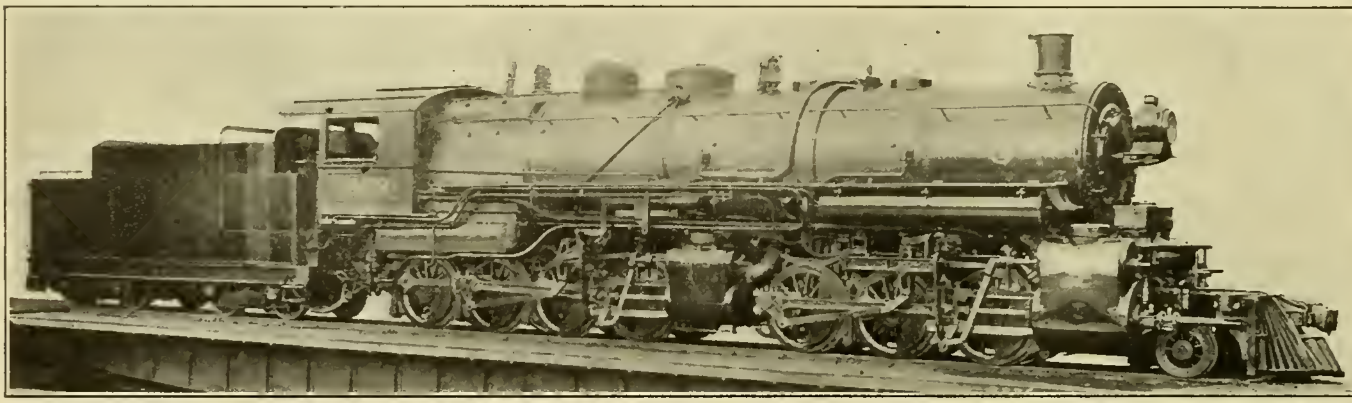
New Electric Locomotives.—The Illinois Traction System is building six heavy electric locomotives at its shops in Decatur, Ill. They will be equipped with four General Electric, 600-h.p. motors with Sprague-General Electric, multiple unit type M control. The trucks will be furnished by the American Locomotive Company and the air-brakes will be Westinghouse EL. The locomotives will resemble in general outline the steel turtle-back cars in use on this line, and will be 34 ft. long, 9 ft. 3 in. wide. They are to be equipped with M. C. B. couplers and steel pilots.

MALLET ARTICULATED LOCOMOTIVES, 2-6-8-0 TYPE

Great Northern Railway.

The Baldwin Locomotive Works have recently completed ten more Mallet articulated compound locomotives for the Great Northern Railway. The general features of the locomotives of this type heretofore used on this line have been published in this journal.* The principal changes embodied in the design of the new engines are as follows:

The use of a separable boiler, with a feed-water heater in the front section, and an Emerson superheater in the rear section. A change from the 2-6-6-2 to the 2-6-8-0 wheel arrangement. An increase in the cylinder diameters, and the use of piston instead of slide valves. A general revision in the design of the more important details, such as the articulated frame connection, reversing gear, etc.



ARTICULATED LOCOMOTIVE OF THE 2-6-8-0 TYPE—GREAT NORTHERN RAILWAY.

Boiler.—The boiler is straight topped, and the firebox (Belpaire type) is similar to that used in the previous Great Northern engines. The back head slopes forward, and is stayed above the crown by gusset plates. These plates are cut out to accommodate the transverse bolts which stay the outside shell above the crown. The barrel is composed of two rings, and contains 307 tubes 15 ft. long. Thirty-two of these tubes are 5 in. in diameter, while the remaining 275 are 2¼ in. in diameter. In front of the tube sheet is a sohrt combustion chamber, surmounted by a manhole. The separable boiler joint surrounds the front end of this chamber. The feed water heater is 5 ft. 2 in. long over tube sheets, and contains 582 tubes, each 2¼ in. in diameter. These tubes are distributed over the entire cross section, except at the center, where the heater is traversed by a flue 11 in. in diameter. This flue is riveted to the tube sheets, which are suitably flanged for the purpose.

Steam and Exhaust Piping.—The dome is located immediately in front of the firebox, and the throttle communicates with a horizontal dry pipe of ordinary construction. This pipe terminates in the combustion chamber, where it is connected, by means of a tee-head, with the superheater headers. These are, in shape, not unlike ordinary steam pipes.† Each header is divided into two compartments, and has cast upon it suitable lugs which are bored out to receive the superheater pipes. These pipes are expanded into the headers and are arranged with a double loop in each large boiler tube. The loops are connected by cast steel return bends. The 5 in. boiler tubes are grouped in four rows, two of which are placed back of each header.

The superheated steam is conveyed to the steam chests through short horizontal pipes. These are connected to the superheater headers through a saddle casting bolted to the under side of the combustion chamber, and cored out to convey the high pressure exhaust steam to the receiver pipe. This casting, furthermore, is provided with a cinder pocket for cleaning the combustion chamber.

The high pressure exhaust steam, after passing through the saddle casting, is conducted by a cast iron elbow, to a horizontal pipe located in the large central flue of the water heater. A second elbow, placed in the smokebox, then conducts the steam to the flexible receiver pipe. This pipe is placed on a sharp inclination, and is provided with a ball-joint at each end and one intermediate slip joint. The arrangement of the final exhaust pipe calls for no special comment.

Cylinders, Valves and Valve Gear.—The cylinders are 23 and 35 by 32 inches, and with 55-inch driving wheels and a steam pressure of 200 pounds, the calculated tractive effort is 82,000 pounds. With 359,600 pounds on driving wheels, the resulting factor of adhesion is 4.38. The high and low pressure cylinders are cast independent of their respective saddles. The high pressure valves are 13 in. in diameter, and arranged for inside admission; while the low pressure valves are 15 in. in diameter and arranged for outside admission. The by-pass valves are of the Pennsylvania R. R. style. The relief plates are of cast steel, and each is formed in one piece with a central spindle guide. The two reverse shafts are connected by a jointed reach rod, placed on the center line of the engine, with a flexible joint in the center of the high pressure saddle. The Ragonnet power gear is used, and its cylinder is bolted to the right-hand side of the boiler shell immediately ahead of the high pressure reverse shaft.

Frames and Running Gear.—The frames are of cast steel, and are arranged with a single articulated connection. The low pressure cylinders are bolted and keyed to a steel box casting, which constitutes part of the framing system for the forward engine. This arrangement is reported to have given excellent satisfaction on heavy Mallet locomotives built by the Baldwin Locomotive Works during the past year.

The equalization of the rear engine is continuous, and is arranged with leaf springs over the boxes of the fourth and fifth pairs of drivers. The frames are supported under the firebox by three inverted leaf springs on each side, and these are connected to yoke equalizers placed over the boxes of the sixth and seventh pairs of drivers.

The equalization of the front group of wheels is arranged with yokes over the boxes of the leading drivers. These yokes are connected to a transverse beam of cast steel and from this beam is suspended an inverted leaf spring. The back end of the forward equalizer rests on the middle of this spring, and the equalizer is fulcrumed under the steel box casting which supports the low pressure cylinders.

Other Details.—The front section of the boiler is carried on

* See 1906, pp. 371, and 1907, pp. 213.
† See American Engineer, Feb., 1910, pp. 64.

two supports, both of which are under load. The rear support is placed under the water heater, and the front support under the smokebox. The latter is fitted with the controlling spring.

Sand is delivered to the rear group of wheels from a box placed over the boiler, and to the forward group from a separate box located well down, between the low pressure cylinders.

The injectors are non-lifting, and are placed right and left under the cab. They force water directly into the heater, keeping the latter constantly filled. The outlet from the heater is placed on the top center line, and water is delivered to the boiler proper through two checks, placed right and left immediately back of the front tube sheet.

The smokebox contains a high single nozzle, in front of which is placed the adjustable diaphragm. A petticoat pipe is located under the stack. The smokebox arrangement is characterized by simplicity and freedom from draft obstruction.

TENDER.—The tender is designed in accordance with Great Northern practice. The frame is composed of 12 in. channels, and the trucks are of the equalized pedestal type with cast steel center, steel-tired wheels.

The satisfactory results so far given by Mallet locomotives on the Great Northern is evidenced by the fact that up to the present time 77 of these engines have been built for this company by the Baldwin Locomotive Works. As the new locomotives are equipped with feed-water heaters and superheaters, it should be possible to accurately determine the respective economies resulting from the application of such devices.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	82,000 lbs.
Weight in working order	378,300 lbs.
Weight on drivers	359,600 lbs.
Weight on leading truck	18,700 lbs.
Weight of engine and tender in working order	526,000 lbs.
Wheel base, driving, front	10 ft.
Wheel base, driving, back	15 ft.
Wheel base, total	43 ft. 11 in.
Wheel base, engine and tender	76 ft. 2½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.38
Total weight ÷ tractive effort	4.60
Tractive effort × diam. drivers ÷ total heating surface	783.00
Total heating surface ÷ grate area	74 00
Weight on drivers ÷ total heating surface	62.50
Total weight ÷ total heating surface	65.60
Volume equivalent simple cylinders, cu. ft	24.10
Total heating surface ÷ volume cylinders	239.00
Grate area ÷ vol. cylinders	3.24
CYLINDERS.	
Kind	Compound
Diameter	23 and 35 in.
Stroke	32 in.
VALVES.	
Kind	Piston
Diameter, H. P.	13 in.
Diameter, L. P.	15 in.
WHEELS.	
Driving, diamcter over tires	55 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6 x 12 in.
BOILER.	
Style	Belpaire
Working pressure	200 lbs.
Outside diameter of first ring	84 in.
Firebox, length and width	117 x 96 in.
Firebox plates, thickness	⅜ and ⅝ in.
Firebox, water space	F. 6, S. and B. 5 in.
Tubes, number and outside diameter	275—2¼. 32—5 in.
Tubes, length	15 ft.
Heating surface, tubes	3,038 sq. ft.
Heating surface, firebox	225 sq. ft.
Heating surface, total evaporating	3,263 sq. ft.
Superheater heating surface	480 sq. ft.
Feedwater heating surface	1,797 sq. ft.
Total heating surface*	5,780 sq. ft.
Grate area	78 sq. ft.
TENDER.	
Wheels, diameter	36½ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons

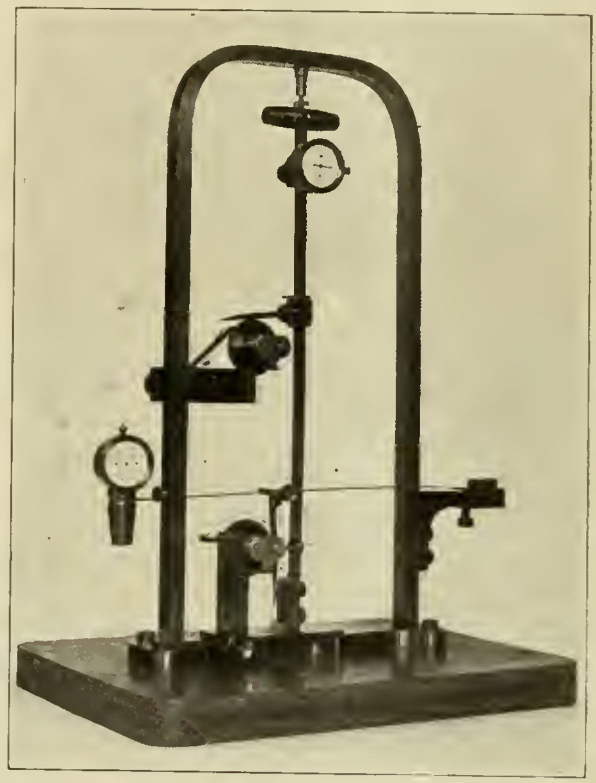
* Sum of the evaporating heating surface, 150 per cent. of the superheating surface and the feedwater heating surface.

NEW STORAGE BATTERY CARS.—Sixteen of the new Edison storage battery cars have been ordered by the officials of the Twenty-eighth and Twenty-ninth street crosstown line. In the three weeks' test of the car on that line it was operated at a cost of only 4.3 mills per mile.—*Ry. Elec. Eng'r.*

INSTRUMENT FOR TESTING TRACK.

The Pennsylvania Railroad has devised an instrument, which will accurately register every vibration, either vertically or horizontally, of a car attached to a regular passenger train, and thus permit accurate comparisons being made of the riding qualities of the track on any two sections of the road. This instrument is placed on the floor of the car, and is fitted with horizontal and vertical pendulums or bars of flexible steel secured at one end and having a a hammer or weight at the other. The vibration of the car causes these bars to vibrate and the dial located near the hammer registers the maximum amount of the movement and the number of vibrations. A form of cyclometer is attached to each bar and gives a record of the total distance covered by the vibrations, *i. e.*, the cyclometer will give the total movement of the flexible bar for the entire trip and hence a severe vibration will give a record which would require a large number of smaller ones to equal.

This instrument is used in determining the winners in the competition between the supervisors and their assistants, to whom each year a sum of nearly $11,000 is awarded in prizes for excellence in track maintenance. The test also includes observation of the movement of water in two glasses placed on the sills of the windows in the rear of the car and an allowance is also made for the relative speed of which the train is operating over any section. From these records a fairly accurate estimate can be made of the riding qualities of the various sections of the track and the decisions for the award of the prizes arrived at.



INSTRUMENT FOR TESTING TRACK—P. R. R.

AMPERE HOUR METERS ON NEW YORK CENTRAL.—The New York Central has recently installed ampere hour meters on all of its diners and buffet cars which are electrically lighted. This equipment includes about 35 diners and 25 buffet cars. Ampere hour readings have been found to be especially advantageous in car lighting service on this road inasmuch as one coach yard in which these cars are finally placed has so little clearance between tracks that it is practically impossible to open the battery doors, and accordingly gravity readings of the battery are out of the question.—*Ry. Elec. Eng'r.*

RAILROAD ELECTRIFICATION *

In the few remarks which follow it is not the purpose to discuss the paper directly but to present certain aspects of the general subject, of more or less general character, which are the outgrowth of the speaker's ten years' experience in trying to demonstrate to railway men the various ways that electricity can be advantageously utilized in connection with various railway problems.

There are a few general items of railway transportation problems that have a bearing on, and explain the apparent slow progress made in trunk line electrification, such as:

1st. The question of mere method of train haulage is only a small part of the question.

2d. The advocates of electric traction have been dwelling on only a small portion of the various elements involved in the cost of transportation.

3rd. The electrical engineer has had a tendency to prejudice his case in advance by apparent lack of knowledge, or clear conception of the elements composing the problem.

4th. Unfortunately the effectiveness of the advocated engineering recommendations are somewhat diminished by the fact that the advice given is not always disinterested.

5th. The electrical achievements thus far, while mainly confined to passenger traffic, have shed little light, except in special cases, on the larger problem of freight train operation.

A review of some of the problems and operating results of railway managers may lead us to a better appreciation of the magnitude, variety and rare skill necessary for the achievement of success. For example:

1st. The freight rate per ton mile in Great Britain is 2.31 cents, against ¾ cents in this country. The revenue per ton mile, in Germany, is 1.41 cents, or nearly twice the figure for the United States. This also in face of the fact that the wages per man in the United States is 82 per cent. greater than in Germany and 140 per cent. greater than in England.

The operating ratio, *i. e.*, the ratio of expenses to gross earnings in the United States, is 67.5 against 69.1 for Germany and 63 in England.

2nd. The average ton of freight handled by our railways is moved 33 miles for the same cost one pays to the coal dealer to transport a ton of coal across his lawn.

3rd. Notwithstanding the increase in operating costs, during the past ten years, due to advance in wages, materials and supplies, the operating ratio or proportion of operating expenses to gross earnings, has advanced only from 67.06 per cent. in 1897 to 69.67 per cent. in 1907, whereas the advance in cost of labor and materials, during the same period, if it was not checked by other factors, would have practically wiped out net earnings. How then did the railways escape bankruptcy? The answer is found from the following figures taken from the Interstate Commerce reports, which show the enhanced efficiency of train movement. This is essentially the record of management:

Year to June 30.	Tons Carried One Mile (Millions).	Freight Train Mileage (Millions).	Average Train Load, Tons.	Passengers Carried One Mile (Millions).	Passenger Train Mileage (Millions).	Passengers per Train Mile.
1897..........	95,139	464	204	12,256	335	37
1898..........	114,077	503	226	13,379	334	39
1899..........	123,667	507	243	14,591	347	41
1900..........	141,596	492	270	16,038	363	41
1901..........	147,077	491	281	17,353	385	42
1902..........	157,289	499	296	19,689	405	45
1903..........	173,221	526	310	20,915	425	46
1904..........	174,522	535	307	21,923	440	46
1905..........	186,463	546	322	23,800	459	48
1906..........	215,877	594	344	25,167	479	49
1907..........	236,601	629	357	27,718	509	51
Increase per ct.	148.7	35.5	75	126.1	51.9	37.8

These figures represent what the men in charge of the railways have done, through the agency of capital and brain power, applied to the reduction of grades, elimination of curves, installation of additional side tracks and terminal yards, the purchase of larger and better cars, locomotives, etc.

The foregoing figures (mainly from D. Crombie, of the Grand Trunk Railway System, and a digest of the Interstate Commerce reports by E. W. Harden) give an inkling of the railway managers' problems and the broadminded views such results naturally produce, necessitating a long look ahead, and would naturally lead the railway manager to take the initiative as regards the consideration of electricity as an element in the problem.

4th. The efficiency of transportation is such that the average distance on all railways, each shipment travels, is 131.7 miles; the average mileage per car is 23.5 miles per day. At this rate, each car load shipment consumes $\frac{(131.7)}{(23.5)}$ 5.6 days.

Again, the average mileage per month, for a freight locomotive, is 3,000. By double crewing or pooling, this mileage can be increased approximately only 25 per cent., which goes to show that the mileage actually made is independent of the potential capacity of the locomotive or the method of propulsion.

Of the foregoing average of 5.6 days per shipment, the part which the element of mere translation plays, is only six per cent. of the total time, so that if this was entirely eliminated the total saving would be insignificant.

Per contra, there is a great opportunity for the legitimate employment of electricity in effecting economies in the balance of the cycle which would show up very attractively. The possibilities in this regard are foreshadowed by the unique and well nigh revolutionary achievements in loading and unloading vessels at the ports on the Great Lakes.

The speaker fully recognizes the possibilities of electric operation, as to gain in capacity, etc., where the circumstances admit of utilizing this capacity, at least in passenger train work, but this splendid inherent capacity is not possible of realization in freight service at the present time because the transportation limitations which now vitally control the mileage of the steam locomotive, would operate and prevent the electric locomotive doing any better with the added handicap of doubling the capital investment.

The foregoing is respectfully submitted in the hope of suggesting, first, the kind and quality of railway talent to be met with, and second, the sort of knowledge, experience and mental furnishing demanded of the electrical engineer in order to make effective headway in electric exploitation in the steam railway field. It is quite obvious that we must understand the railway language and possess adequate knowledge of the railway game.

There was one thought I really meant to bring out a little more clearly, but I refrained from doing so because I went into details quite largely in the discussion* to which Mr. Darlington referred in opening the paper; but I think it is a thought that will appeal to all steam railroad men—the average monthly mileage that a freight locomotive makes is 3,000 miles. The limitations which govern this low mileage are not due to mechanical or engineering limitations or causes for which the motive power department is responsible. The potential possibility of an engine is such as to be capable of making an average of 9,000 miles per month, provided a clear road was available; but what limits the mileage of locomotives are terminals and passing sidings. So that if we had the proper terminals and side tracks, as President Hill of the Great Northern has said, we could more than triple the present monthly mileage of our locomotives.

Now, a great many of our electrical friends, myself included, in the early stages of the art, assumed that that 3,000 miles capacity represented the physical limitations of the steam locomotive, and, knowing the ability of the electric locomotives to perform continuous service for 23 hours out of the 24, immediately assumed from the fact that that represented the difference in potential possibility between the electric locomotive and the steam locomotive. Now, the facts are these: Inasmuch as the limita-

* A discussion by L. R. Pomeroy of a paper, "The Present Status and Tendencies of Railroad Electrification," by F. Darlington before the Central Railway Club.

* See AMERICAN ENGINEER, p. 41, February, 1910.

tions are entirely outside of the motive power department, and due entirely to transportation considerations, there is no assurance that we could get any more mileage out of the electric locomotive than we are now getting out of steam, with the added handicap of assuming a much larger capital charge—two things in the speaker's judgment that will have to be considered. In the first place, these terminals will have to be provided, and adequate side tracks furnished, so that enough mileage can be made to justify the expenditure; and the second point is that the improvement and reduction in first cost from the electrical side has got to be of a very marked nature before electrification of trunk lines can become very general.

HIGH SPEED FORGING PRESS.

Hydraulic forging presses have been very generally used for forgings of large size because of the practical impossibility of satisfactorily working the metal to the center of the ingot under a steam hammer of any size. Such presses as have been in use for very heavy work are slow in operation and until recently the many advantages of forging work over hammer work were not available for light or moderate forgings because of this fact.

As much as ten years ago the metal workers of England and Germany started the development of a machine which would permit the use of forging presses on small and moderate size work without any sacrifice of time and with a decided improvement in the quality of the product. This effort was moderately successful, even at the start, and machines of this character have been in use in those countries for as much as ten years and at the present time the perfected machines are very extensively employed. The original design, however, was subjected to a long period of development before the present thoroughly satisfactory machines were obtained.

During the past two or three years metal workers in this country have recognized the advantages offered by the high speed forging presses and they are becoming decidedly popular. The United Engineering and Foundry Co., of Pittsburgh, has acquired the sole right to manufacture the machines which were developed by Davy Brothers, Inc., of Sheffield, England, who have been designers of steam hammers and hydraulic forging presses for many years and the illustrations show two sizes of the machines that are now being furnished by them.

These machines offer the advantages of press work over hammering at any point where a steam pipe may be carried and also have the additional advantage of actually reducing the cost of the work. Therefore not only may a more thorough working of the metal be affected, but it can be done at a lower price than by a steam hammer, while at the same time the danger to workmen from flying tools or pieces of forgings and the shocks and jars to the building and its foundation are eliminated. The maintenance cost of the machines is low, as might be expected when it is realized that the moving parts of these machines operate through inches and at comparatively low speed while a steam hammer operates through feet at high speed.

The development leading up to this finished machine is interesting and shows how the unexpected and apparently insurmountable difficulties have been overcome, resulting in a thoroughly practical and efficient design. This work has been done by Davy Bros., who began with a simple press deriving its pressure from a pump. This arrangement was not only very slow, but compelled the water at high pressure to pass through valves and relatively long lines of piping, many joints and had the other drawbacks of a large water system.

Following the pump operated press the next step in the development was the employment of a hydraulic intensifier, which made it possible to increase the pressure on the press from about 2,000 lbs. to 6,000 lbs. per square inch. This greatly reduced the size of the press cylinders and the volume of water required, bringing a press of large power down to practical dimensions. This type of machine, however, still required a pump and the system usually included a large accumulator in addition to the intensifier and required a number of valves and levers for its operation. This type of press was also slow, due to the number of valves operated and the slow speed of the intensifier and therefore an improvement was made by the employment of a steam intensifier which eliminated many of the difficulties that previously existed. In this case the pump was discarded and two pistons, having a ratio of about 40 to 1, were directly connected, steam operating the larger one which was set at the bottom, resulting directly in a high water pressure,

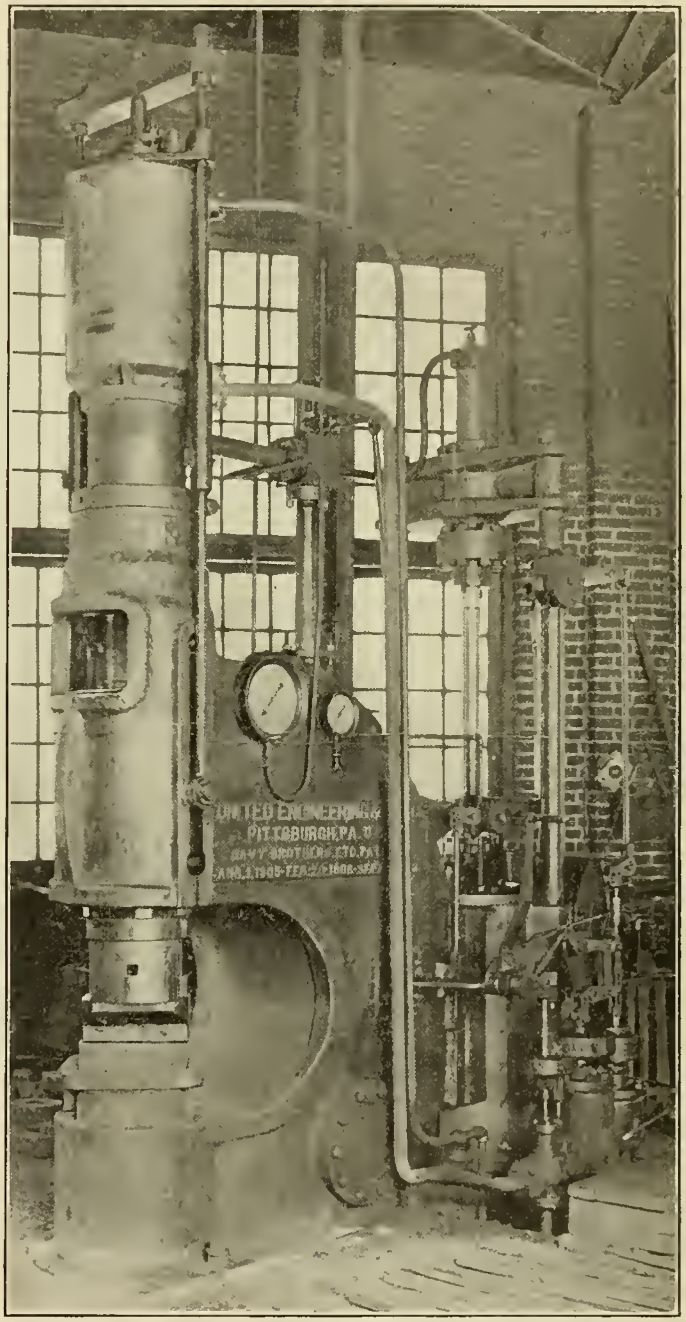


FIG. 1.—150 TON, SINGLE FRAME PRESS.

the steam being used only for the pressing stroke, since the weight of the pistons would perform the return stroke without assistance. Steam being highly elastic could be handled at a very high rate of speed and since the water pressure cylinder could be connected directly to the main cylinder of the press without valves, most of the former difficulties were eliminated. The size of the two water cylinders, *i. e.*, intensifier and press, was in a ratio of about 12 to 1, so that the press head while operating at the same time and in an amount 1/12 as far as the intensifier cylinder was subject to very accurate control. This arrangement gave a rapid working stroke satisfactorily and by the placing of a steam cylinder on top of the machine, arranged to take steam on one side of the piston only, the return stroke was also accomplished quickly. The return or balancing steam cylinder is arranged so that it does not exhaust the steam, but simply forces it back and forth in the main pipe.

While the principles of this machine were undoubtedly correct it is evident that unless the intensifier be of very large proportions the stroke of the press will be very short and a machine of sufficient capacity for ordinary forging work would be impractical on account of its size and the large amount of steam required to operate it. In order to overcome this difficulty it was decided that the proper thing to do was to lower the press head nearly in contact with the forgings by means of the steam balance cylinder, which is already provided for the return stroke and then put the intensifier into operation for the pressing stroke. This was done and only required the addition of a tank connected with the high pressure system and controlled by the check valve, so as to provide the varying amount of water required for different length strokes. The check valve in the line between the tank and press cylinder was arranged to open automatically as the head was lowered ready for operating and a lever was provided to raise the check valve when the press head was lifted, allowing the balance cylinders to force back into the tank an amount of water that will give the proper position of the press head. This arrangement greatly reduces the size of the intensifier and the amount of steam required to operate it, since it is in use only when forcing down the press head the amount that the forging is reduced.

It was found that this press was very satisfactory so far as one stroke was concerned, but when rapid action was required it was impractical to operate the number of valves or levers required. If these levers were operated out of time the result was disastrous to the machine or work and the speed of the machine was necessarily restricted to the speed of the operator in handling the levers. Therefore the next step was the development of a single lever control, which has now been perfected and one lever operates all valves and permits putting the press through an entire cycle of motions in one forward and back motion of the lever. The valves cannot be crossed and the press follows exactly the stroke of the hand lever, both as to speed and distance traveled. This lever is so arranged that back of the vertical center line corresponds to the light stroke from 2 to 6 ft., according to the size of the press, and forward of that line is the power stroke, 2½ to 6½ in., in accordance with the size of the press. With this arrangement the press can be brought down 2 to 6 ft. on top of the forging and the forging reduced from 2 to 6 in. by one motion of the hand lever. Then the press can be brought all the way back or any part of the way back by simply moving the lever to the required position. If the lever is only brought back to the center line the press head will return only the amount of the forging stroke, which can then be repeated as often as the lever can be moved. In practice this is as high as 150 strokes per minute in the small presses and 60 in the large ones. This stroke, which is repeated as often as the blow of a steam hammer, is at a much lower velocity, since the press moves only inches where the hammer moves feet.

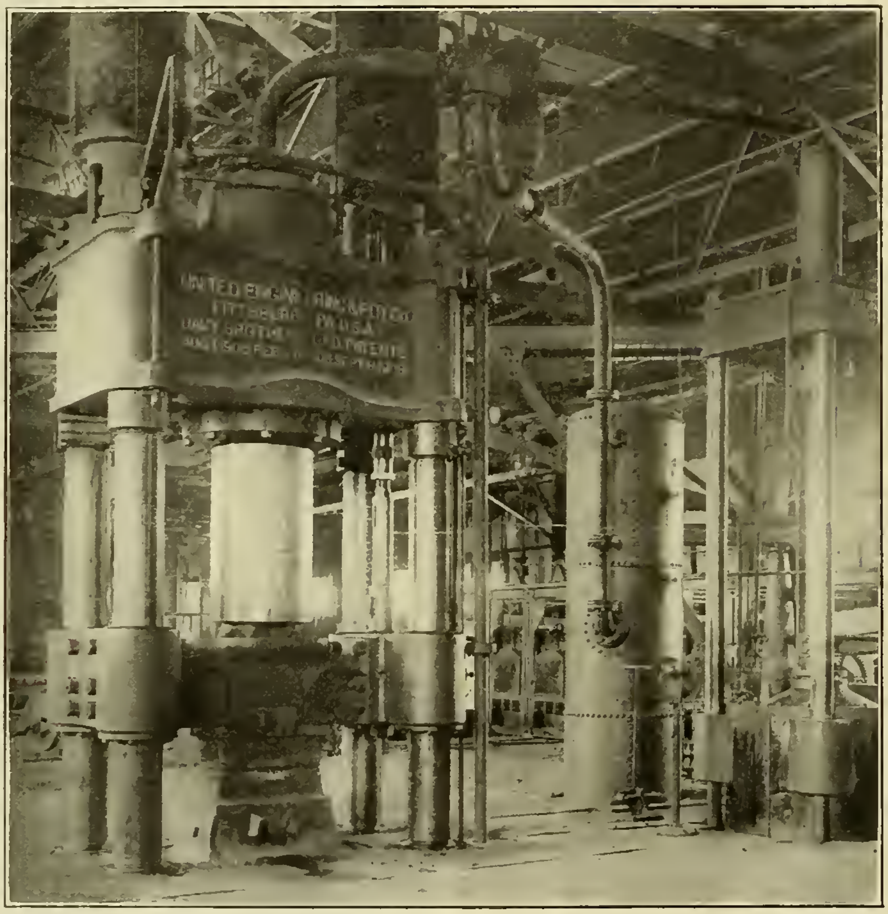


FIG. 2.—1,200 TON, FOUR COLUMN PRESS.

In cutting or punching, the hand lever can be set for a certain travel and the press head will ride forward just that distance, even though the resistance is suddenly and entirely removed. The machine does not require a large foundation and there is no vibration transmitted to surrounding buildings.

A large number of these presses have been furnished by the United Engineering and Foundry Co., which are working on a very diversified line of forgings, including cogging down ingots, wheel forgings, locomotive forgings and general work.

Some of the work which is being done on these machines is shown in the illustrations and clearly indicates the advantages of the press over the steam hammer in many classes of work.

Figure 3 shows a shaft 13½ in. in diameter and 19 ft. long with 27 in. diameter flanges which was forged on a 2,000 ton press from a 36 in. ingot in two hours, requiring but two heats.

In Figure 4 is shown a 14½ in. shaft 20 ft. long with a coupling at one end, which was forged on a 1,500 ton press from a 36 in. ingot in one heat, time required being one hour.

A 500 ton press made the disc shown in Fig. 5, which is 22 in. in diameter and 5 in. thick, from a 14 in. square ingot, in one heat, requiring 19 minutes. This includes punching the 4½ in. hole. The same size press made the hex nut shown in Fig. 6 in eight minutes, one heat being required.

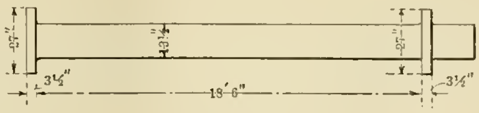


FIG. 3

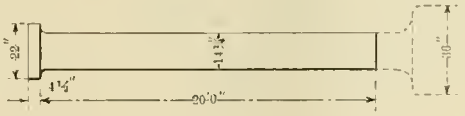


FIG. 4

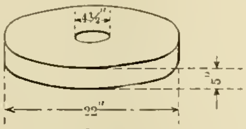


FIG. 5

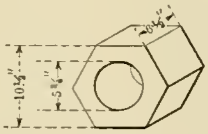


FIG. 6

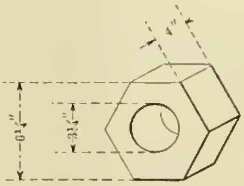


FIG. 9

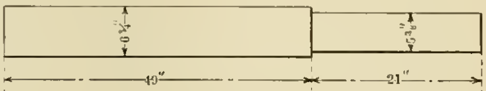


FIG. 7

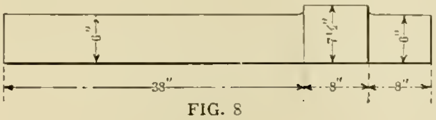


FIG. 8

EXAMPLES OF WORK DONE ON HIGH SPEED FORGING PRESS.

Figure 7 shows a shaft which was forged from a 7 x 7 in. billet on a 300 ton press in 12 minutes, in one heat.

A 150 ton press made the eccentric shaft shown in Fig. 8 from an 8 x 8 in. billet in 13 minutes, one heat being required. The same press made the hex nut shown in Fig. 9 from 5 in. round stock in 10 minutes, including the punching.

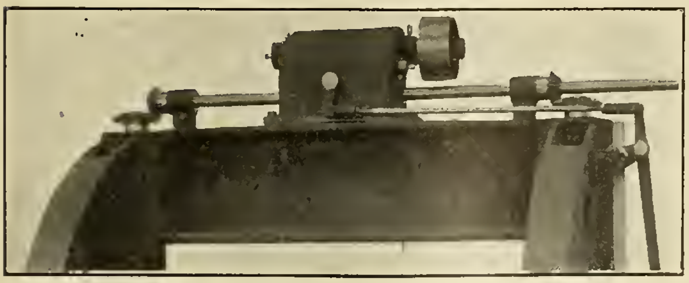
In cogging down ingots a 1,200 ton press working 16 x 16 in. ingots to 10 x 10 in. and cutting them up into pieces 18 in. long will average 16 tons per hour.

It is of course necessary for a machine doing work of this character that all the material and workmanship shall be of the very highest grade and special attention is being given to this by the manufacturers. They are also carefully providing for the easy and quick renewal of such parts as are subject to wear without dismantling any large part of the machine. Chilled surfaces and accurate grinding are used wherever desirable.

The address of the United Engineering and Foundry Company is Farmers' Bank Bldg., Pittsburgh, Pa.

PLANER ELEVATING DEVICE

An improved power elevating device as shown by the accompanying half-tones has recently been brought out in which the direct drive gears are used for lowering the rail and the compound gears, which would also give a reverse motion, are used



REAR VIEW, SHOWING OPERATING DEVICE.

to raise the rail, the compounding giving the necessary power, enabling the operator to raise the rail at comparatively slow speed and lower it at almost double the speed. The stand is bored out and fitted with bushings in such a manner that the top shaft which carries the pulley can be withdrawn with the bushings intact and inserted from the other side, so that when making various styles of drives, which are sometimes very complicated on account of the odd dimensions of motors, the pulley can be used on either side. As the power elevation device is used but very little it has been designed so that the pulley and top shaft are the only revolving parts, all of the gears being idle, when not in use.

This device is both powerful and very sensitive and is operated by two small clutches on the top shaft. The two oilers on

FRONT VIEW, SHOWING LOCATION ON PLANER HOUSINGS.

the top shaft and one at the end supply all the oil that is required, and by having a bearing on each side of the main driving gears, all danger of springing the shaft is eliminated. The rear view shows clearly the simplicity of the operating device. On the extreme right is shown the handle for manipulating the clutches and also the small handle for locking it in a central position so that it cannot be thrown in by accident.

The above device was designed and is supplied by the Cincinnati Planer Co., of Cincinnati, Ohio.

Pennsylvania Terminal in Manhattan.—The story of the Pennsylvania Railroad's great enterprise, its genesis, progress and completion, is told by C. M. Keys in an attractive article in the July number of *World's Work.* This story appearing under the title "Cassatt and His Vision," is fully illustrated and will be found very complete, as well as interesting, by any one interested in the successful venture planned by a great executive. In this article the author not only describes the great terminal, but also the details of financing this great project, which together with a few other improvements required the expenditure of about half a billion dollars in ten years. It includes a history of the forty years of effort to cross the Hudson River and a story of the work and policy of a great American railroad.

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Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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* Illustrated articles.

ELECTRIFICATION OF RAILWAYS.

The paper on "The Electrification of Railways," by George Westinghouse, president of the American Society of Mechanical Engineers, which was presented before a joint meeting of that society and the Institute of Mechanical Engineers in London, is very interesting not only to railroad men, but also the public in general; however, it must be remembered that it may possibly be somewhat partisan.

In this connection we desire to call attention to a recent discussion by Mr. Pomeroy of the paper on "The Status and Tendencies of Railroad Electrification in America," by F. Darlington, before the Central Railroad Club, which appears in this issue. This is an entirely disinterested discussion of this important subject, following the idea in Mr. Pomeroy's article on a similar subject which appeared in the February number of this journal, showing that the limitations which now vitally control the mileage of the steam freight locomotive would also operate in the case of the electric locomotive, thus preventing any better results and with the additional handicap of doubling the capital investment.

Much has been said and written on this subject recently, both in this country and abroad, showing that there certainly is no lack of interest, especially by men prominent in engineering and railroad work, who have spent considerable time investigating many of its conditions and phases.

For certain severe and unusual conditions of service many railways have found it desirable to inaugurate electric operation. In some instances, in congested suburban districts, this change was brought about by means of legal pressure to eliminate the smoke nuisance, and in many others where the traffic leads through tunnels, by the necessity to render train operation more safe and reliable, but in all of these cases electrification extends only over very limited distances, and for this reason especially, it is difficult to get much information or data for an accurate comparison with that relating to steam operation. In spite of all that has been done and all data available at the present time, the progress in electric traction for handling freight has been very slow. This is no doubt due to the lack of sufficient data to determine the possibility of obtaining a full realization from the large amount of capital to be invested, especially in view of the limitations imposed by the lack of sufficient terminal facilities, etc.

EDUCATION OF FIREMEN.

It is reported that on the Lehigh Valley Railroad there has recently been inaugurated an educational movement to increase the efficiency of firemen, similar to that which was started some time ago on the Pennsylvania Lines and a number of other railways. This is undoubtedly a step in the right direction, and it is to be hoped that other roads may realize the importance of this matter and soon follow their example.

The chief difficulty in most cases seems to be the determination of a correct principle on which to base this instruction. In this connection some very good suggestions were offered in the discussion of the paper on this subject at the Atlantic City conventions.

One important condition which makes it imperative for the railroads to have well trained firemen is the waste of fuel. Every heat unit going up through the smoke stack in the form of unburned gases, or down into the ash pan as green coal instead of converting water into steam represents a certain amount of actual money loss. The increase in the cost of fuel during the last few years has rendered still more urgent the necessity for getting out of fuel all the energy that is possible. Besides, it should be remembered that a well trained fireman will eventually become an engineer who, because of this training, will no doubt be able to get a much better performance from a locomotive than he could without it.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

FORTY-THIRD ANNUAL CONVENTION.

(CONTINUED FROM PAGE 296.)

LOCOMOTIVE AND SHOP OPERATING COSTS.

Committee: H. H. Vaughan, Chairman; W. C. A. Henry, M. J. McCarthy, Le Grand Parish, G. W. Seidel.

The committee appointed to report on the subject of Locomotive and Shop Operating Costs considered it advisable to confine themselves to one of the various classes of expenses which might be included under that description. Such costs, as a whole, are, evidently, too complicated for the purpose of a single report, comprising, as they do, those of fuel, repairs, enginehouse expenses and various other items. They will, therefore, chiefly discuss those included in the account "Repairs of Locomotives," and the method adopted in supervising the expenditures of that description.

Inquiries made of a number of the largest railroads show that the appropriation plan for determining pay-rolls is in general use. As a rule, an estimate is prepared by the divisional authorities, stating the amount they require for their pay-roll during the coming month, compared with the actual figures for the preceding month, and corresponding month in the previous year, and an explanation of the reason for any increase desired. These estimates are consolidated into a statement at headquarters, and, after any criticism or alteration has been decided on, are approved, and practically constitute an authority for the expenditure in labor called for. Generally, it is understood that such authority is not to be exceeded unless in case of emergency, and in some cases no over-expenditure is permitted without additional authority being obtained. It is evident that such a rule cannot be enforced in the case of roundhouse forces, which must necessarily be maintained, but it may be more or less closely adhered to in general repair shops. On several roads, weekly or biweekly pay-roll statements are prepared for the purpose of checking the actual expenditures against the estimates, but this practice does not appear to be usual, although, no doubt, it is carried on locally even if not recognized as part of a regular system. At the end of the month it is usual to compare the actual with the estimated pay-roll and require an explanation of any increase over the figures approved. This system appears to work successfully and enables close control to be maintained over labor expenditures without unnecessary complication, provided it is handled reasonably and firmly. While it deals with the pay-rolls as a whole, it actually limits the expenses on any one account, since the distribution will usually bear certain proportions.

The limitation of pay-rolls, while requiring in a way the exercise of economy and the production of the best results from a given amount of labor, cannot by itself be considered as a complete system. If permanently persisted in beyond certain limits, the condition of the power would deteriorate, or the number of engines requiring repairs would increase. The condition that exists is broadly that a certain amount of work is to be done and that the cost will depend on the efficiency with which it is accomplished. The peculiarity of repair work depends on both of these. In this respect, it differs from the usual run of manufacturing operations on which the work to be done is usually determined, or at any rate is not a question for constant watchfulness. In the maintenance of locomotives the amount of work required to keep them in repair per mile may vary widely, and may have a greater effect on the ultimate cost than the efficiency with which it is performed. In the case of running repairs no system appears to have been developed by which any alteration in the work required or its efficiency may be promptly detected. The piecework system in roundhouses has been used and, of course, determines the cost of doing the work. It would, consequently, also detect any increase in its quantity, but it is unfortunately not suitable in many ways for work of this nature. The thorough specification of the various operations is exceedingly complicated, and the time required to properly give out the work and check it is a serious proportion of that of doing it. While, therefore, it has been worked with a fair measure of success, it is not entirely satisfactory for roundhouse purposes. On one road a system is in effect by which all mechanical department officials are furnished daily with the labor expenses incurred on the territory under their supervision. This expense is shown in detail; that is to say, it is divided into ordinary locomotive repairs, wreck and other repairs, shop tools and machinery, manufacturing work, etc. This information is, of course, more accurate than that of the pay-roll alone, as it specifies the distribution among the various accounts. Another road is trying a system by which roundhouse foremen are notified weekly of the labor charges against running repairs on each engine handled in their terminal. In this case it is possible to watch the cost of maintaining individual engines, and the information is furnished with the idea that any cause leading to unusual expense may be more promptly brought to attention. The whole question of the proper supervision of running repairs is, however, a difficult one. The cost is about one-half of the total cost of locomotive repairs, but the number of engines involved and the variety and small cost of the majority of the operations performed make any detailed watching exceedingly complicated. The work required on any individual engine also varies considerably from day to day. It will run for a time with comparatively little expense and may then require considerable work for a period. For work of this kind, it would appear questionable whether much more can be done than to closely watch the pay-roll or distributed labor at each terminal and its relations to the business handled. When these are properly proportioned, any increase in the work required will be quickly known by the foreman in charge, who is in the best position of anyone to discover the reasons. In the case of shop repairs, it is possible to exercise considerably closer supervision. These repairs are occasional in place of being practically continuous, as running repairs, are. They can, consequently, be more carefully analyzed, and their cost compared with the service rendered. The distinction between running repairs and shop repairs varies on different roads, from a repair costing over $5 for labor to one costing $400 total. This variation is not important for the purposes of this report, although it affects to a certain extent the practice which is followed in supervising shop repairs.

Several roads require estimates to be submitted and authority obtained before shop repairs are made on an engine. In some cases this applies to all shop repairs, in others to all those over a certain amount, varying from $75 upward. The authority of an executive officer may be required for repairs over a limit which varies from $1,000 to $5,000. Notice of an engine requiring repairs may be submitted thirty days before engine is shopped, in order to enable the cost of the repairs recommended and the service of the engine being investigated. In one case, in which each class of engine is given an allowance per mile for repairs, engines may be shopped without authority if the cost of the repairs will not cause the allowance to be exceeded; otherwise, it must be obtained. When estimates are made, their correctness may be checked by comparison with the actual cost when completed, and explanation required if exceeded. There are, naturally, many variations in the details with which this work is carried out on different roads, but some system for watching the cost of shop repairs in advance is in general use. The committee would call attention to the fact that the most important question when an engine requires shop repairs, is the miles made since last repaired. While criticism of the nature of the repairs required may occasionally lead to additional mileage being obtained from an engine by the application of minor repairs, this condition is not usual, and, as a rule, the cost of the repairs can not be economically reduced by estimates made before an engine is shopped. Such estimates are difficult to make accurately, and may tend to limit the repairs to the amount allowed. Limiting repairs that are actually required to put an engine into good condition is not economy. Whatever may have been the reason, after an engine has been taken out of service and sent to the shops, the cheapest plan is to then make the repairs properly and thoroughly, so that when turned out the engine will make as many miles as possible before needing to be again shopped. The cost of shop repairs is not properly the cost per repair. It depends on the cost per mile, and the miles made between repairs are, therefore, equally as important as the cost of the repairs when made. All shop repairs are not necessarily those which put an engine into thoroughly good condition, but whatever be their nature, the question of their being justified by the mileage made is the one of greatest importance. For this purpose, information as to the miles made since last general overhauling and the nature and cost of the intermediate repairs received will show whether the class of repairs called for should be necessary or not. The introduction of an allowance per mile has the advantage of presenting the influence of large or small mileage in dollars and cents in place of miles only. Whether this is used or not, a simple statement, involving the shop repairs since last general overhauling, the mileage made and the nature of the repairs required, really gives all the information that can be advantageously used in determining whether the engine has been properly maintained and used and a reasonable mileage obtained from it. If the repairs are actually needed there is little doubt that they should be thoroughly made, and to do this in the most economical way is then a problem for the shop.

The great degree of variation in the amount of work required in making locomotive shop repairs, even though they are classified as being of the same general nature, makes it almost impracticable to watch their cost as a whole. When this is done, the best system in use is that which furnishes the foreman or shop superintendent a daily or weekly statement of the labor applied on the individual engines under repair, usually divided to show that in each department separately. By this means, information is obtained while the work is in progress, which will call attention to any engine on which the labor is exceeding the expected amount. The difficulty usually experienced is that on account of one engine requiring more work than another the differences are difficult to analyze, and, if thorough analysis is attempted, the work has to be split up into a number of different operations so that the cost of each may be individually known. Where piecework or any of the various efficiency systems are in use, this is, of course, the case, but, apart from any question of rewarding labor, the cost of the individual operation appears to be the only logical basis on which the cost of locomotive repairs can be determined in the shop. It is true that much of the work done, even when divided with considerable detail, still varies to a certain extent from one engine to another, but this variation is not sufficient to prevent knowledge being obtained of what the work is costing and enable any increase being immediately known. Whatever may be the system employed, some method of watching the cost of repairs in detail enables the efficiency of a shop to be supervised in a way that is not otherwise possible. The committee does not believe it is necessary to discuss the various systems in use for this purpose. They have been fully dealt with at other times and are generally known and understood. One point may, however, be referred to. Any operation may be reduced to a series of detail operations, and the time required for those may be determined with considerable accuracy. For instance, in turning an axle, the time required to lift the piece, place it in the lathe, take the various cuts, roughing and finishing, and replace it on the floor, may all be individually recorded and thus compared with corresponding operations on other pieces or with known performances. Such records are now generally known as time studies, and their use enables the time required for numerous operations being checked from known data, in place of depending on the results obtained from the man performing the work or the judgment of the foreman in charge. Locomotive shops have the advantage that the work performed in them is repeated time after time, and, under this condition, there are few operations that do not repay time spent in making the proper study of the best method of performing them. What is, however, perhaps equally important, is the means they afford of comparing, for similar operations, the relative costs of different methods or of different types of machines. Such comparisons are evidently valuable when applied to the various repair shops on a railroad, and the committee has investigated the possibility of arranging for their exchange among some of the members of this Association. The advantages of such a course are, from one point of view, obvious. There are numerous operations which vary but little in different repair shops, and the determination of the best method or result would be far more certain if derived from the experience of the shops on several railroads than from those of one. Comparisons of total times of most operations would be misleading, on account of the differences in conditions and practice, but the same objection does not apply to properly determined time studies, as the details may be readily adjusted to allow for differences in design, conditions, etc. The opinion of those of our members who have been consulted differs as to the advisability of such exchange. Some have signified their willingness to co-operate, while others do not care to. There are, evidently, difficulties connected with the course apart from the practice on some roads of not divulging time or piecework schedules. A road giving information would naturally expect to benefit by receiving from others to a reasonably equal extent, and means by which this could be ensured are not easy to devise. The shops in which this work has been carried out are limited in number, and in many cases it is only partially completed. The committee, therefore, considers that at the present time it would be unwise to recommend any arrangement for the interchange of time studies, although it believes that in the future some benefit might be obtained if a suitable plan could be outlined.

In considering the methods used for watching the results obtained, as opposed to those that have been discussed for watching the expenditures being made, the most important statement is, of course, the performance sheet. The form in which this is made out varies considerably on different roads, and in many cases references are made to units which are evidently retained on account of the familiarity with them of those concerned. Apart from performance sheets there are, however, a number of statements in use which it will be interesting to refer to.

Most roads prepare statements showing cost of shop repairs by classes of engines and nature of repairs, in some cases these being compared with estimate made when engine was shopped. One road reports a very good method for recording the cost of shop repairs, keeping separate the cost of the following divisions of the work:

Stripping.	Remove flues.
Repair rods.	Repair flues.
Take off frame.	Replace flues.
Repair frame.	Boiler work.
Put on frame.	Driver brake and rigging.
Remove cylinders No. —.	Air pump, governor, piping, etc.
Apply cylinders No. —.	Driving boxes.
New fire box.	Steam pipes.
Front flue sheet.	Lagging.
Back flue sheet.	Jacket.
—— side sheets.	Paint engine and tender.
Flue sheet and —— side sheets.	Tank repairs.
Flue —— side and —— door.	

In this case the cost of the various items shown are charged separately, and it is evident that a far better comparison is obtained than when the cost is simply shown as a total. In another case the labor on each engine is reported by departments, such as machine shop, boiler shop, erecting shop, etc., and in this case also any tendency to increased cost can be fairly well localized. An output unit may be used based on the tractive power of the engine or its weight. The latter is stated to afford a better comparison of the cost of repairs than the number of engines turned out.

Statements are generally used showing cost of running repairs by classes on different divisions. In some cases cost of individual engines running repairs are not kept separately, but by classes of engines only. This statement would appear to be of considerable value in comparing results, as it enables a comparison to be made on engines of similar types and service. An allowance per mile is sometimes used for different classes of engines. This has already been referred to, but its use in a statement of this nature has another purpose. When an allowance per mile is used for shop and running repairs combined, the surplus accumulated by each engine may be watched, and knowledge thus obtained as to whether that engine when repaired will have performed its service at the cost per mile expected. If, however, the allowance is separated for shop and running repairs, the mileage made between shopping in itself determines whether or not the engine can receive its shop repairs without exceeding its shop repair allowance, while the performance of the engines based on their allowance for running repairs distinguishes in an easy way between those classes or divisions which are costing more or less than the average. In addition, if the allowance be based on the engine mile, the tractive power mile, or the engine ton-mile, whichever unit may be used in comparing results, such a statement shows which classes or divisions have exceeded or which have run below the allowed rate, and, therefore, enables the causes of overexpenditures to be localized to that extent.

A similar statement may also be used for shop repairs, but in that case a difficulty arises from the fact that the number of engines shopped on a road or a division does not necessarily bear any relation to the miles run. Over a considerable period the condition of the power can not vary sufficiently to make the difference important, but for one month, or, indeed, for several, shop repairs may be reduced below those required to maintain the power in a uniformly good condition or may be required in excess of the normal in order to improve it. This difficulty may be remedied by referring the cost of each engine receiving shop repairs to the mileage made by it since last repaired, and working out the cost per mile on this basis, in place of comparing the cost to the mileage run during the month. By this means, the cost for each engine or class of engines determines for those repaired during each month their cost per mile for shop repairs since their last shopping, and thus enables the expensive or economical classes to be located without respect to the number of them shopped during the month. It is thus possible to prepare a statement which shows the results of the month's shop repairs with the same accuracy as that showing those for running repairs. Evidently in such a statement the cost of the shop repairs may be made to balance with the charges against that account for the month, but the mileage, and, consequently, the cost per mile, will vary from that run by engines during the month, as it is based upon that made by the engines shopped since last repaired. Over a considerable period the mileage would correspond if no power were purchased or scrapped, but under usual conditions the mileage run exceeds that shopped, owing to that made by new and scrapped engines. The difference is not important, however, and a statement made on this basis has the advantage that the cost per mile for shop repairs is obtained with the same accuracy as that for running repairs, and without reference to the relation between the amount of shop repairs effected in any month and the mileage run during that month. When combined with an allowance per mile or other unit, it is then possible to localize the engines which exceed or are below the average cost and the amount by which they affect the result.

On several roads, while statements showing cost of individual repairs are not prepared separately, the cost per mile for different classes of engines on different divisions is shown in the performance sheet. This can not, however, be said to be general. The performance sheet is usually arranged to show results as a whole rather than in detail, the latter being analyzed by departmental statements. For this purpose there is a tendency to introduce a unit which will afford a better comparison than the engine mile. Owing to the large variation in the size of locomotives now in service and the greater cost of maintaining them as the size increases, the cost per mile no longer compares the expense with the service rendered. The ton-mile is decidedly less accurate, since, while the cost of maintaining the same class of power does not vary greatly in level and hilly districts, the load hauled by them does, and, in fact, the engine that is working on heavy grades, while it may not haul more than one-third the load that it would on the level, costs slightly more to repair per mile run. While, therefore, the cost per ton-mile is important from an operating standpoint, its use in connection with locomotive repair costs introduces a variable which can not be affected by the efficiency with which those repairs are handled. The unit needed is one that takes into account the size and capacity of the engine and those in use are either based on its weight or its tractive power. The weight may be taken as the total weight of the engine without tender, the light weight of the engine or the weight on drivers. The latter corresponds very closely to the tractive power and appears to be the preferable unit. While the total weight of the engine represents, presumably, the power that is available for hauling trains, as it is reasonable to assume that it has been disposed of to the best advantage, whether a small tractive power was required for high speeds or a large one for low, yet, the weight on drivers or the tractive power is more closely proportioned to the cost of maintenance. In the case of two engines of equal weight, one constructed as a ten-wheeler, the other as a consolidation, the ten-wheel engine will not only cost less per mile to maintain, but will usually cost less per mile per pound of tractive power or weight on drivers. Again, when two engines of equal weight are employed, the one in freight and the other in passenger service, the cost will usually be less for the passenger engine when based on the tractive power mile, and, as the tractive power or weight on drivers usually bears a smaller proportion to the total weight on passenger engines than in freight, it is evident that if the truth of these two propositions be granted, the unit based on pound of tractive force or weight on drivers represents more accurately than one based on the total or light weight of the engine, the comparative cost of repairs. As between the two former there is little to choose, but as the tractive power represents more closely the service delivered, the committee feels that it is the preferable unit, and wishes to recommend the more general use of it. They consider that the best method is that in which the tractive power of the engine is expressed as a percentage of 100,000 pounds, so that an engine having a tractive power of 30,000 pounds is called a 30-per-cent engine, the tractive power being calculated at 85 per cent of the boiler pressure. The use of such a unit is valuable in including in the cost of maintenance a factor that varies with the increasing size and cost of power, and, consequently, presents that cost with closer reference to the service rendered.

The committee does not feel that any useful purpose would be served by a discussion of the various forms of performance sheets in use. On most roads the desire exists for figures that are comparative with those of past years and rendered useful through custom. The exact way in which these figures are presented is of less importance than the retention of familiar methods which enable them to be easily used. They have investigated the willingness of a number of roads to enter into an arrangement for exchange of performance sheets, a plan that should be mutually interesting and advantageous. The replies are not unanimous, but sufficient roads have stated that they would be willing to do this to make the proposition worth recommending. The variations that previously existed in the classification of accounts have now been done away with, so that this objection to the interchange of information no longer exists. While, no doubt, conditions vary widely on different roads, yet, the consolidation of railways into large systems has led to comparisons between roads in one system which vary just as much from one another as do those which are entirely separate. Mutual exchange of results should, therefore, prove of considerable advantage to those of our members who care to enter into an arrangement for this end. The Master Mechanics' Association could be of use in this matter, by ascertaining which roads would be willing to exchange results and furnishing mailing-lists, or preferably printed addresses, so that the work of sending out the information would be facilitated. It does not appear advisable to exchange performance sheets as a whole. They usually contain a good deal of information that is not of value except to the officers of the road for which they are prepared, and the committee herewith submits the following form, which they would suggest as meeting the requirements for furnishing such results as would be valuable and interesting to exchange.

NAME OF ROAD.

Month of ...., 191..

ITEMS.

Number of locomotives.
Average haulage capacity, per cent.
Total locomotive mileage.
Total gross ton-mileage.
Per cent of locomotives in service.
Per cent of locomotives under and waiting repairs (shop).
Per cent of locomotives under and waiting running repairs.
Repairs per locomotive-mile, total.
Repairs per locomotive-mile, shop.
Repairs per locomotive-mile, running.
Fuel, pounds per locomotive-mile, passenger.
Fuel, pounds per locomotive-mile, freight.
Fuel, pounds per locomotive-mile, all classes.
Fuel, pounds per 1,000 ton-miles, passenger.
Fuel, pounds per 1,000 ton-miles, freight.
Fuel, pounds per 1,000 ton-miles, all classes.
Lubricants, cost per locomotive-mile.
Lubricants, cost per locomotive-mile per 100 per cent capacity.
Other supplies, cost per locomotive-mile.
Other supplies, cost per locomotive-mile per 100 per cent capacity.
Enginehouse expenses, cost per locomotive-mile.
Enginehouse expenses, cost per locomotive-mile per 100 per cent capacity.

Notes.—Haulage capacity per cent equals tractive power at 85 per cent of the boiler pressure divided by 1,000, *i. e.*, an engine of 100 per cent capacity is one having a tractive power of 100,000 pounds.

Results per mile per 100 per cent capacity are based on mileage of each engine or class of engines multiplied by its capacity.

State distinction between shop and running repairs..........

This excellent report was not read on the floor of the convention because of the absence of any member of the committee and therefore was not given any discussion.

SIZE AND CAPACITY OF SAFETY VALVES FOR USE ON LOCOMOTIVE BOILERS.

Committee:—F. M. Gilbert, James Milliken, W. D. Robb, M. H. Wickhorst, J. G. Neuffer.

The remarks and suggestions below will relate to locomotive boilers only. Further, they relate only to locomotive boilers using coal as the fuel, and under the conditions now prevailing for the stimulation of the draft by the use of exhaust steam from cylinders of the locomotive and by means of the ordinary steam blower.

A series of tests were made for the committee by Mr. E. D. Nelson, Engineer of Tests, of the Pennsylvania Railroad, to determine the maximum or worst condition that the safety valves were required to take care of. With the gauge pressures of 190 to 207 pounds, it was found that the maximum discharge of steam was 2.44 pounds, the minimum 1.18 and the mean 2.05 pounds per square foot of heating surface per hour.

The committee has taken twice this mean value as the basis for a formula, which, in their opinion, will reduce safety-valve practice to a uniform basis, and at the same time provide proper relief for the boilers. Such a formula may be expressed as follows:

$$A = \frac{0.08 H.S.}{P}$$

A = Outlet of valve in square inches.
H.S. = Boiler heating surface in square feet.
P = Absolute pressure = gauge pressure + 15 pounds

This formula will provide, on boilers carrying 200 pounds gauge pressure, an outlet that will take care of 4.1 pounds of water per square foot of heating surface per hour.

A number of observations were made on locomotives in passenger service, provided with safety valves, the combined outlets of which would take care of from 3.64 to 4.06 pounds of steam per square foot of heating surface per hour, and no cases were found where the safety valves failed to properly relieve the boilers. The locomotives on which investigations were made carried 200 pounds gauge pressure, had 4,231 square feet of heating surface and 56½ square feet of grate area.

Past investigations have verified that Napier's rule for the flow of steam may be safely taken for the types of muffled safety valves now on the market.

It is, perhaps, superfluous to state that, having assigned proper values for safety valves, means should be provided for maintaining those values. In other words, the maintenance of proper areas of outlet should be a feature of safety-valve maintenance and repair.

For the guidance of the designer, the valve manufacturers' lists should show nominal size of valve, the outlet in square inches, under various pressures, and the capacity for discharge of steam in pounds under the various pressures. For the guidance of the repair man, the lifts of valves under the various pressures should also be shown.

In the discussion it was objected that the committee had not specified the lift of the valve in determining the area of the opening and that the method of determining this area should be more clearly specified.

Upon request of one of the members, Mr. Gilbert stated that it was the custom on the New York Central on locomotives having two safety valves to set one at 2 lbs. pressure above the other and in cases where there were three safety valves the third one is set at 3 lbs. higher pressure than the second or 5 lbs. higher than the first.

Upon motion the report of the committee was accepted.

SUPERHEATERS.

In 1901, the Canadian Pacific Ry., under the pioneer leadership of Mr. Roger Atkinson, of the Canadian Locomotive Works, introduced the use of superheated steam on locomotives in America. A few years later Mr. H. H. Vaughan extended the use, and the success of the superheater is due in a great measure to his push and energy. To-day we have reports from twenty American roads which have more or less engines equipped.

The circulars asked for answers based on comparative tests made as to certain particulars. However, the circulars requested that the data as to costs, etc., for superheater and non-superheater locomotives be taken from regular service records covering a considerable period of time.

Railroads answering having superheaters: American, 20; foreign, 2.

Superheaters on American roads reported as follows:

A., T. & S. F.	168
Boston & Maine	1
C. & N. W.	1
Canadian Pacific	487
C., B. & Q.	5
Central of Georgia	1
C., R. I. & P.	9
Erie	1
Great Northern	61
M., St. P. & S. S. M.	1
National Ry's. of Mexico	1
Northern Pacific	36
N. Y. Cent. (L. S. & M. S.)	2
Oregon Short Line	2
Pennsylvania	1
Pittsburg, Shawmut & Northern	1
Southern Pacific	2
St. L. & S. F.	21
W. & L. E.	1
Union Pacific	3
Total	805

Railroads answering, but not having superheaters: American, 34; foreign, 9.

Superheaters which are considered and number of engines reported, as follows:

Types of Superheaters.	Number of Railroads.	Number of Engines.
Baldwin	12	79
Churchward (England)	1	61
Cole	6	13
Emerson	2	59
Jacobs	1	104
*Schmidt	3	58
Union Pacific	1	1
Vaughan-Horsey	5	491

* Schmidt superheaters are used on 130 railroads in Europe, and in service, or in course of construction, on over five thousand locomotives.

[*The report contains illustrations and brief descriptions of the various types of superheaters, all of which have been given in this journal except the Union Pacific type, which is given below.*—Ed.]

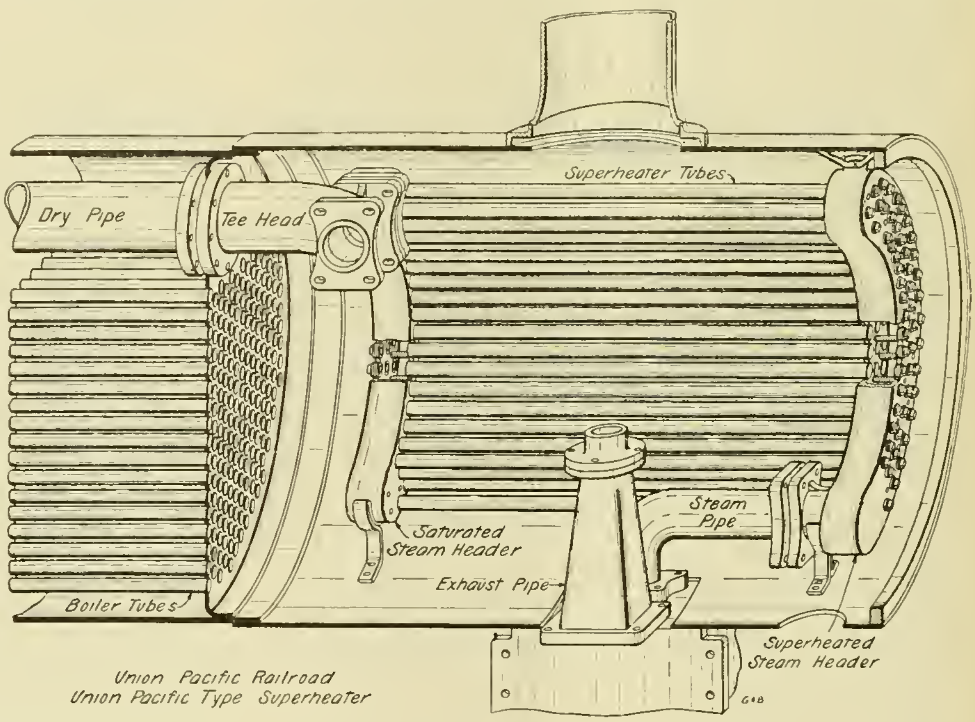
UNION PACIFIC SUPERHEATER.

The Union Pacific superheater (see illustration) is of the smoke-box type, and in effect is the usual steam pipe transformed into a superheater by increasing the area and splitting it up into a number of small tubes.

The steam pipe forms vertical headers of a crescent shape at the front and rear of the smoke box, and between them are placed 108 2-inch tubes, arranged horizontally. The ends of the tubes are fastened to the headers by the usual method of expanding with a roller, the roller being inserted in a hole in the header opposite the tube, which is afterwards closed with a screw plug.

The steam passes into the top of the rear headers, thence forward through the tubes to the front headers, thence downward to steam-pipe connection to the steam chest.

The more important items of running repairs, valve oil and coal, are arranged in tabular form, and the per cent. of saving or increased cost of the superheater is given, as follows:



Union Pacific Railroad
Union Pacific Type Superheater

COST OF RUNNING REPAIRS PER 100 TON-MILES OR PER PASSENGER CAR MILE

Road.	Superheater.	Non-Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
BALDWIN SUPERHEATER				
A., T. & S. F.	Comparisons not available, as superheater and non-superheater engines do not run on same district.			
Central of Georgia	.038	.046	17.4	....
C., B. & Q.	.018	.026	30.8	....
	.024	.026	7.7	....
Oregon Short Line	.0234	.0225	...	4.0
Southern Pacific	.059	.050	...	18.0
COLE SUPERHEATER.				
Boston & Maine (Pass.)	.0725	.0641	...	13.1
Wheeling & Lake Erie	.0366	.0342	...	7.0
JACOBS SUPERHEATER.				
A., T. & S. F.	.124	.161	23.0	....
SCHMIDT SUPERHEATER.				
C., B. & Q.	.031	.027	...	14.8
	.030	027	...	11.1
Great Northern (Pass.)	.0403	.0807	50.0	....
	.193	.092	...	110.0
VAUGHAN-HORSEY SUPERHEATER.				
Canadian Pacific (Freight)	.024	.0408	41.1	....
	.0415	.0477	13.0	....
Canadian Pacific (Pass.)	.0306	.0376	18.6	....
	.0290	.0287	...	1.0
C., B. & Q.	.0150	.0270	44.5	....

COST OF VALVE OIL PER MILE

Road.	Superheater.	Non. Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
BALDWIN SUPERHEATER.				
Oregon Short Line	.00123	.00103	...	19.0
Southern Pacific	.00137	.00118	...	16.0
COLE SUPERHEATER.				
Wheeling & Lake Erie	.00118	.00059	...	100.0
SCHMIDT SUPERHEATER.				
Great Northern (Pass.)	.00175	.00137	...	27.7
	.00254	.00132	...	92.5
VAUGHAN-HORSEY SUPERHEATER.				
Canadian Pacific (Freight)	.0110	.0077	...	43.0
	.0074	.0061	...	21.3
Canadian Pacific (Pass.)	.0067	.0069	2.9	....
	.1162	.0064	3.1	....

COST OF COAL PER 100 TON-MILE OR PER PASSENGER CAR MILE

Road.	Superheater.	Non. Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
BALDWIN SUPERHEATER.				
C., B. & Q.	.0114	.0122	6.5	....
	.0106	.0122	13.1	....
Oregon Short Line	.200	.230	13.0	....
Southern Pacific	.0135	.0135	...	....
COLE SUPERHEATER.				
Wheeling & Lake Erie	.0169	.0191	11.5	....
JACOBS SUPERHEATER.				
A., T. & S. F.	.0116	.0170	31.8	....
SCHMIDT SUPERHEATER.				
C., B. & Q.	.0105	.0130	19.2	....
	.0109	.0133	18.0	....
Great Northern (Pass.)	.0195	.0208	6.2	....
	.0207	.0248	16.5	....
VAUGHAN-HORSEY SUPERHEATER.				
Canadian Pacific (Freight)	.148	.153	3.3	....
	.219	.298	26.5	....
Canadian Pacific (Pass.)	.0115	.0199	42.2	....
	.0187	.0194	3.6	....
C., B. & Q.	.0098	.0120	18.3	....

TROUBLES REPORTED IN REPLY TO CIRCULAR LETTER.

BALDWIN SUPERHEATER.

A. T. & S. F.—Some trouble with steam-pipe joints leaking; front end fills up.

C. B. & Q.—No trouble.

Central of Georgia.—No. This engine has record of not having a single failure in making 30,595 miles.

Erie.—Front end fills up with cinders. Cinders also ruptured several superheater pipes so they had to be plugged.

Nat'l. Rys. of Mexico.—Front ends fills up with cinders. No remedy at present—experimenting.

Oregon Short Line.—No trouble. Twelve months' service.

Pennsylvania.—No trouble.

Pittsburg, Shawmut & Nor.—Front end fills up.

Rock Island.—Cinders cut superheater tubes due to sand-blast action. Front end filled up with cinders and engine does not make steam.

Southern Pacific.—No trouble.

Union Pacific.—No data.

COLE SUPERHEATER.

C. & N. W.—Very little.

Boston & Maine.—Superheater flues at firebox end expanded and beaded instead of screwed. Gaskets leaked between headers and T-head; improved design has obviated this trouble. Superheater flues have given trouble by filling up; blower applied and works well. Other small defects, for instance, leaks at junction of the superheater pipes and return bends ascribed to defects of material rather than of design.

New York Central.—A little trouble in roundhouse on account of keeping joints tight; not serious, however.

Northern Pacific.—Cinders in passing through tubes wear out return bends. Gaskets at connection between small superheater pipes and main header give same trouble.

Rock Island.—Had trouble with Field tubes stopping up. Changed to return-tube system and had no trouble. Had trouble with joints and fastenings. Recent designs obviate this trouble.

Wheeling & Lake Erie.—No.

EMERSON SUPERHEATER.

Great Northern.—Threaded pipes in return bends break off. Now welding pipe into the return bend.

JACOBS SUPERHEATER.

A. T. & S. F.—Occasional leaks in steam-pipe joints. Recent designs have joints on the outside.

SCHMIDT SUPERHEATER.

C. B. & Q.—Leaks in front end overcome by providing more secure fastening for the blocks connecting superheater pipes to the header and by bracing the header to smoke arch. Clinkers formed on back end of superheater pipes; cleaned off every trip.

European Railways.—So far as we know, neither the superheater itself nor the large smoke tubes have given any trouble in European practice. In a few isolated cases, the large smoke tubes have begun to leak at the fire-box side; in such cases, investigation has shown that the tubes were not properly expanded in the tube sheets, nor according to our recommendations. These defects have been easily remedied, after which no further difficulty was experienced. No difficulty has been experienced in European practice in keeping the joints of the superheater elements tight. An essential requirement, however, is that the bottom facing of the collector casting shall be properly machined and that the right kind of copper-asbestos gaskets shall be used for these joints; and, further, that the bolts shall be taken up after the engine has been for the first time under steam. In most cases the large smoke tubes have to be blown out every day to avoid clogging. But there are railroads, as for instance the Belgian State Railways, which blow the tubes out only every three days on the average. This largely depends upon the kind of fuel used.

Great Northern.—Yes. Gaskets leak, also threaded pipes in return bend break off. Now welding the pipe into return bend.

Northern Pacific.—Cinders wear out return bends. Gaskets at connection between small superheater pipes and main header give same trouble.

UNION PACIFIC SUPERHEATER.

Union Pacific.—No.

VAUGHAN-HORSEY SUPERHEATER.

Canadian Pacific.—Originally gave trouble, due to unsuitable gaskets between superheater pipe and header fittings. Since remedied by using stronger style of gaskets. Nuts connecting pipes to fittings originally made of brass, found to corrode, were replaced by cast steel, and later by drop-forged nuts, which has overcome the trouble. Nuts slacked off remedied by using special nutlocks and by making closer fit of the threads. Cast-iron headers cracked, caused by faulty construction; has been remedied by improved design. The tubes blocked at the return bends; has been overcome by systematic inspection and using proper appliances for cleaning and blowing out tubes.

C. B. & Q.—No more trouble than other engines.

New York Central.—Practically no trouble. Old design of holder broke once or twice, but new design gives no trouble.

Northern Pacific.—Cinders in passing through tubes wear out the return bends. Gaskets at connection between small superheater pipes and main connection give same trouble.

Union Pacific.—No trouble.

REDUCTION OF BOILER PRESSURE.

The answers show that the general practice is to reduce the boiler pressure when superheater is applied; at the same time, where there is a considerable reduction made, the diameter of the steam cylinders is increased. On the A. T. & S. F., tandem compound engines have had the high-pressure cylinder removed when superheater was applied, and the boiler pressure reduced from 220 to 160 pounds.

Where reduction of boiler pressure is made the general result shows a reduction of boiler repairs.

LUBRICATION OF SLIDE-VALVE ENGINES.

With the Baldwin superheater, four roads report slide valves on superheater engines as having no trouble in lubricating with superheat from 11 to 44 degrees.

With the Schmidt superheater, Dr. Schmidt reports European practice: "Slide valves have been tried in a few instances on superheated-steam locomotives and to our knowledge they could be worked with a fair measure of satisfaction up to a steam temperature of about 450° F. The trouble experienced with higher degrees of superheated steam on slide-valve engines is due, in our opinion, not so much to the difficulty of lubrication as to valve warping at higher temperature and seizing on its flat seat."

With the Vaughan-Horsey superheater the Canadian Pacific reports that it is impossible to lubricate slide valves above 190 degrees superheat. A heavier valve oil is used on superheater engines than on non-superheater engines.

The Union Pacific has one slide-valve engine equipped with Vaughan-Horsey superheater, and has had trouble in lubricating with a superheat of from 160 degrees to 219 degrees.

LUBRICATION.

Forced lubrication is found to be unnecessary with low and moderate degrees of superheat. Different kinds of pumps have been used on some roads when first installing superheaters and later on abandoned for the ordinary sight-feed lubricator. Of course, it is natural that superheater engines should show a little increase in the cost of cylinder lubrication over the non-superheater, but you can buy several pints of valve oil for the price of a ton of coal. In Europe, where a high degree of superheat is the practice, it is found that forced lubrication is necessary.

PISTON AND VALVE RINGS.

The result from the majority of railroads indicates that it is unnecessary to use a special mixture in casting piston and valve rings.

The New York Central, with the Cole and Vaughan-Horsey superheaters, uses a mixture containing more copper.

The Canadian Pacific, with the Vaughan-Horsey superheater, reports "had difficulty at first; have made progress and are still experimenting."

The St. Louis & San Francisco report that they recently received twenty Pacific-type engines with the Emerson superheater. The cylinder packing that came with these engines gave out in about 1,500 miles. They are now using a special metal

The Union Pacific, with Vaughan-Horsey superheater on a slide-valve engine, found it necessary to apply a bronze false valve seat.

The Canadian Pacific gave results as to life of cylinder and valve packing rings for the year ending October, 1909. In freight service, packing rings on engines without superheater ran from two to three times as long as the rings on the superheater engines. In passenger service the difference was not so great. In one case the life was the same, while in another case the life of rings on the non-superheater engines was nearly double that of the superheater engines.

SUPERHEATED STEAM ON COMPOUND ENGINES.

The Jacobs superheater on the Santa Fe is the only superheater reported which superheats the steam between the high and low pressure cylinders on compound engines. These superheaters are now in service on tandem, balanced and Mallet compounds. Tests on this road prove that greater efficiency can be obtained from a superheater giving superheat between the high and low pressure cylinders, than from superheater giving superheat to high-pressure cylinders only.

DAMPERS.

The Baldwin, Emerson, Union Pacific and Jacobs superheaters have no dampers and experience no trouble from pipes burning out.

The Cole, Schmidt and Vaughan-Horsev superheaters have dampers on all roads reported, except the Great Northern (Schmidt superheater), where the damper interfered with the drafting and was taken out. The dampers are automatic in action, opening and closing as the throttle is opened or closed. They experienced no trouble from pipes burning out.

DO BOILER TUBES ON ENGINES EQUIPPED WITH SUPERHEATERS GIVE TROUBLE?

All reports show that boiler tubes on engines equipped with superheater give no more trouble than engines not equipped with superheater.

PACKING ON PISTON AND VALVE RODS.

The roads using Baldwin and Jacobs superheaters report that it is not necessary to use any special kind of packing on piston and valve rods.

The New York Central (Cole superheater) reports a packing used with a higher melting point.

The Great Northern (Emerson and Schmidt superheaters) use a special metal for rod packing when the temperature in the steam chest is above 600 degrees.

The Canadian Pacific and New York Central (Vaughan-Horsey superheater) use a special kind of packing on outside admission valves.

BOILER REPAIRS.

The Canadian Pacific (Vaughan-Horsey superheater) was the only road from which were received figures showing cost of boiler repairs.

Class of Engine.	Cost Per Engine-mile. Superheater.	Non-Superheater.
4-6-0 — D 6	.19 cents	.91 cents
2-8-0 — M 4	.33 cents	.30 cents
4-6-0 — E 5	.65 cents	.46 cents
4-6-0 — E 5	.47 cents	.31 cents

TESTS.

Tests have been made on the Central of Georgia with Baldwin superheater; Santa Fe, with the Jacobs superheater; Southern Pacific, with the Baldwin superheater; Union Pacific, with Vaughan-Horsey and Union Pacific superheaters; Northern Pacific, with Cole, Schmidt and Vaughan-Horsey superheaters, and are presented in somewhat condensed form.

CENTRAL OF GEORGIA RAILWAY CO.

Engine Test—Southwestern Division Freight Service, July, 1909. Same fifteen carloads of coal hauled in each test; same engineer and fireman each test.

Average or Total for Two Trips.	Engine 1224. Baldwin Superheater. 2-8-0 Type. Cylinders, 22 by 28 in. Weight on Drivers, 143,290 lbs. Boiler Pressure, 160 lbs.	Engine 1222. 2-8-0 Type. Cylinders, 22 by 28 in. Weight on Drivers, 143,290 lbs. Boiler Pressure, 200 lbs.
Time on road	6 hrs. 45 mins.	6 hrs. 45 mins.
Ton-miles	205,740	205,740
Total coal consumed, pounds	24,200	23,700
Coal per 100 ton-miles	11.8	11.5
Total water consumed, lbs.	168,866	166,100
Water per pound of coal	6.98	7.01
Miles run to one ton of coal	16.5	16.9

The results from the Baldwin superheater on the Central of Georgia show no advantage of the superheater engine over the non-superheater engine.

ATCHISON, TOPEKA & SANTA FE RY.

Test of Jacobs High and Low Pressure Superheater on Tandem Compound Engine versus Same Class of Engine without Superheater.*

	Engine 901. 2-10-2 Type. Jacobs Superheater. Cylinders, 19 and 32 by 32 in. Weight on Drivers, 234,600 lbs. Superheating Surface, 1,868 sq. ft. Boiler Pressure, 220 lbs.	Engine 923. 2-10-2 Type. Nonsuperheater. Cylinders, 19 and 32 by 32 in. Weight on Drivers, 234,600 lbs. Boiler Pressure, 220 lbs.
Speed, miles per hour	14.05	13.03
Tonnage	1,332	1,221
Lbs. of coal per 100 ton-miles	24.4	30.4
Saving in coal	19.6%	
Dry coal per I. H. P. hour	3.43	4.10
Decrease per I. H. P. hour	16.3%	
Equiv. evaporation of water	8.10	7.81
Saving in water	3.7%	
Superheat:		
High pressure	19.3° average	
Low pressure	95.0° average	

The superheat in high-pressure superheater averaged 19.3 degrees and in low-pressure superheater averaged 95 degrees. The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation per pound of coal	3.7% gain
Coal per 100 ton-miles	19.6% gain.
Coal per I. H. P. hour	16.3% gain

SOUTHERN PACIFIC RY.

The Southern Pacific has made a test of the Baldwin superheater versus a similar engine without superheater. The superheat averaged 23.2 degrees. The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation per pound of fuel	3.37% loss
Ton-miles per pound of fuel	1.35% loss
Ton-miles per gallon of water	3.32% gain

UNION PACIFIC RY.

The Union Pacific test of the Vaughan-Horsey superheater shows the superheat obtained at varying conditions of speed and cut-off. The maximum superheat is 219 degrees, with an average superheat of 185 degrees.

The Union Pacific test of the Union Pacific type of superheater shows the superheat obtained at varying conditions of speed and cut-off. The maximum superheat is 61.9 degrees, with an average superheat of 48.6 degrees.

The tests on the Northern Pacific give the following results from the Cole, Schmidt and Vaughan-Horsey superheaters:

NORTHERN PACIFIC RY.

Test of Cole Superheater versus Same Class of Engine without Superheater.

	Engine 2137. Cole Superheater. Cylinders, 22 by 26 in. Weight on Drivers, 146,300 lbs. Superheating Surface, 341 sq. ft. Boiler Pressure, 200 lbs.	Engine 2136. Nonsuperheater. Cylinders, 22 by 26 in. Weight on Drivers, 146,300 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	30.26	28.56
Tonnage	556	599
Pounds coal per 100 ton-miles	16.2	20.6
Decrease	21.4%	
Coal per draw-bar H.-P. hour	4.91	6.54
Decrease	25.0%	
Equiv. evaporation of water	10.06	9.94
Saving in water	1.2%	
Superheat	147°	

The relative performance of superheated engine over non-superheated engine is as follows:

Superheat (average)	147 degrees
Equivalent evaporation	1.2% gain
Coal per draw-bar horse-power	25.0% gain
Coal per 100 ton-miles	21.4% gain

NORTHERN PACIFIC RY.

Test of Schmidt Superheater versus Same Class of Engine without Superheater.

	Engine 2137. Schmidt Superheater. Cylinders, 21 by 28 in. Weight on Drivers, 153,504 lbs. Superheating Surface, 248 sq. ft. Boiler Pressure, 200 lbs.	Engine 2136. Cylinders, 21 by 28 in. Weight on Drivers, 153,500 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	15.74	15.00
Tonnage	2,437	2,429
Pounds coal per 100 ton-miles	4.98	5.92
Decrease	15.8%	
Coal per draw-bar H.-P. hour	4.55	5.64
Decrease	19.3%	
Equiv. evaporation of water	9.04	9.13
Saving in water		1.0%
Superheat	147°	

The relative performance of superheated engine over non-superheated engine is as folows:

Equivalent evaporation	1.0% loss
Coal per draw-bar horse-power	19.3% gain
Coal per 100 ton-miles	15.8% gain
Superheat (average)	147 degrees

*For full report of test see AMERICAN ENGINEER, June, 1910, page 233.

NORTHERN PACIFIC RY.

Test of Vaughan-Horsey Superheater versus Same Class of Engine without Superheater.

	Engine 1609. Vaughan-Horsey Superheater. Cylinders, 24 by 30 in. Weight on Drivers, 261,500 lbs. Superheating Surface, 326 sq. ft. Boiler Pressure, 200 lbs.	Engine 1561. Cylinders, 24 by 30 in. Weight on Drivers, 261,500 lbs. Boiler Pressure, 200 lbs.
Speed, miles per bour	10.50	11.77
Tonnage	2,073	2,034
Pounds coal per 100 ton-miles	13.1	16.2
Decrease	19.1%	
Coal per draw-bar H.-P. hour	5.41	6.54
Decrease	17.3%	
Equiv. evaporation of water.	6.87	6.87
Saving in water	—	—
Superheat	121°	

The relative performance of superheated engine over non superheated engine is as follows:

Equivalent evaporation	Equal
Coal per draw-bar horse-power	17.3% gain
Coal per 100 ton-miles	19.1% gain
Superheat (average)	121 degrees

RECOMMENDATIONS.

The experiences gained by various railroads with superheated steam, which have been reported to the committee, indicate that the use of superheated steam on locomotives is both economical and practical. Many types of superheaters with varying degrees of superheat have been used to advantage in railroad service. In the United States there are about 60,000 locomotives, and from reports received there are 317 locomotives equipped with superheaters, or approximately five-tenths of one per cent.

This is such a small proportion that it is evident that the use of superheaters is as yet in its infancy in this country.

With this in view, the committee feels that recommendations as to type of superheater or degree of superheat are not warranted at this time.

The committee feels that this is a most important subject, and one that is worthy of much more time and consideration.

The unanimous opinion of motive power and transportation officials is that the superheater engine gets its load over the division in far better form and in better time than the non-superheater, or, as one superintendent of motive power put it, "'Tis a more snappy machine all around."

Committee:—Lacey R. Johnson, Chairman; F. F. Gaines, R. D. Hawkins, H. W. Jacobs, W. J. Tollerton.

Upon request of Mr. Vaughan, Mr. Hoffman, of the Schmidt Superheating Company of London, was granted the privilege of the floor. Mr. Hoffman spoke in part as follows:—

Of all the data furnished by the committee, the figures given with relation to the saving in coal obtained by the various superheaters will probably be of the most interest to you. With the exception of a few railways, which have used superheaters for very low degrees of superheat all railways report a pronounced saving of coal, amounting to about 20 per cent on the average for simple engines.

Only one railway, the Atchison, Topeka and Santa Fe, has made experiments with the application of superheaters to compound locomotives. The coal saving in their case is stated to have been more than 30 per cent. This is, of course, an exceptionally high figure, especially if the moderate degree of superheat obtained with this particular type of superheater is taken into account. I believe the superheat amounted to only 20 or 30 degrees on the high-pressure side and to about 100 degrees Fahr. on the low-pressure side. In European practice, using superheaters which superheat the steam to more than 200 degrees, the best coal economy so far obtained by the application of a high degree of superheat to compound engines has been between 15 and 20 per cent. The high figure on coal saving given for the Santa Fe test above referred to is probably owing to the special conditions under which those particular engines were tested and are probably only the result of a test of short duration. In the *American Engineer and Railroad Journal* of June, 1910, I find a complete report of the tests with this particular engine and it is stated that the decrease in coal consumption averages *20.8 per cent* for upgrade runs and 11.5 per cent for downgrade runs; this would give an average of about 16 per cent. This would be more within the limits of the coal savings obtained with European compound engines.

I find a further note in the committee's report concerning the application of superheated steam to compound engines, which says: "That the tests on the Santa Fe prove that greater efficiency can be obtained from superheaters giving superheat between the high and low-pressure cylinders, than from superheaters giving superheat to high-pressure cylinders only."

The above note probably refers only to low degree superheaters; in such case the result claimed would be quite natural. Taking for example the steam pressure on the high-pressure side at 220 lbs. per sq. in. and on the low-pressure side at 60 lbs. per sq. in., the temperature of the high-pressure steam would be about 395 degrees, whereas the temperature of the low-pressure steam would only be 307 degrees. A superheater in the case referred to, which is only able to superheat the high-pressure steam 20 degrees, could probably superheat the low-pressure side more than 100 degrees and would therefore be of greater advantage on the low-pressure side. But if a high degree superheater is applied, able to superheat the high-pressure steam, say 200 degrees, then it is better to superheat the high-pressure steam only, in order to get and maintain dry steam in both cylinders, the high-pressure side as well as the low-pressure side, whereas in the arrangement recommended by the Santa Fe the losses through condensation in the high-pressure cylinders are not abolished. Receiver-superheaters have the further disadvantage, that they must provide for a much bigger volume of steam to be superheated than a high-pressure superheater. The steam section in receiver-superheaters must therefore be much bigger, or else wire drawing of the steam in the receiver takes place. These are the principal reasons why, in about 500 compound locomotives equipped with the Schmidt superheater in Europe, only the high-pressure steam is superheated.

Regarding the degree of superheat, the committee did not make any recommendations. In this connection I refer you to the paper on "Locomotive Performances Under Different Degrees of Superheated Steam," showing the amounts of coal used per horse power hour for different degrees of superheat. The curves show clearly that the steam and coal consumption diminishes as the superheat increases, and that there is very little economy obtained with low degrees of superheat, or as Prof. Benjamin puts it in his paper: "The first 80 or 100 degrees of superheat does not make the same proportional decrease in the coal consumption as do the second 80 or 100 degrees increase."

I have here an official report of the Belgian State Railways, a road which has about 400 Schmidt superheaters in service, and which has had experience with Schmidt superheaters extending over 5 or 6 years. It is officially stated that practically no coal saving has been obtained with low degrees of superheat, i. e., with only 60 or 70 degrees. Mr. Schmidt has been advocating high degrees of superheat for the past 20 years; many scientific researches bearing on this question have been made and the same conclusion drawn. There are now nearly 6,000 Schmidt superheater locomotives in service or in course of construction in Europe, all of them using high degrees of superheat. In Europe we have gone through a development similar to that which I believe you are going through now. When superheat on locomotives first came up, many experts believed that it was quite sufficient to get only dry steam in the cylinders. Later on it was believed that the steam would be superheated sufficiently high to remain dry during the cut-off, and now experts are glad if they have still some superheat in the exhaust steam.

Comparatively little heat is required to superheat the steam to a high degree. If we take for instance steam of 200 lbs. pressure, about 1,200 heat-units would be required to generate dry steam of this pressure. Taking the specific heat of superheated steam of 0.6, it would require an additional 30 heat-units to superheat to 50 degrees and 120 heat-units to superheat to 200 degrees. In other words, there is required only about 7 per cent more heat-units to generate highly superheated steam of 580 degrees Fahr. than is required to generate a low degree of superheated steam of only 430 degrees Fahr. Thus the additional heat expended in order to highly superheat the steam does not amount to anything compared with the greater advantage gained by the higher degree of superheat.

The most important point in the whole superheater question is the increase in power obtained by the application of a superheater. This item is not mentioned in the different comparison sheets of the report, but it is touched upon in the final conclusions, which state that "The superheater engine gets its load over the division in far better form and in better time than the non-superheater engine." Giving you a conservative figure obtained in many years' service with thousands of Schmidt superheaters, we can say that the increase in power obtained with a high degree superheater is between 20 and 30 per cent. In other words, one ton of iron in a well-proportioned superheater engine gives 20 per cent more power than a ton of iron in a saturated steam engine. That is the principal reason why superheating has come into so much favor on European roads, and I believe it will prove the principal reason for the general introduction of superheated steam on locomotives in this country.

F. J. Cole presented the following discussion:—

"Superheating for locomotives has passed the experimental stage, and from figures contained in this report and other sources it can be demonstrated that the repairs and maintenance of the apparatus are very slightly, if at all, in excess of an engine using saturated steam. Because the demand for steam on the boiler to perform a certain amount of work is less when superheated steam is used, the boiler repairs, especially in combination with the low steam pressure commonly used on superheater engines, will more than offset any slight additional charge for the maintenance of the superheater apparatus.

The conclusions of the committee are of considerable interest, especially the statement that "superheater engines get their load over the division in far better form and in better time than the non-superheater, and are a more snappy machine all around."

While it is a fact that the number of superheater locomotives running in the United States is very small in proportion to the total number, it is interesting to remember that one or two years ago where probably only one engine in a lot would be built with a superheater, it is now a very common thing to build 20 to 25 or more engines in one lot all equipped with superheaters.

The number of different types of superheaters built by the American Locomotive Company in service or under contract is as follows:

Vaughan-Horsey		215
Cole (old)	103	
" (new)	130	233
Schmidt		73
Emerson		5
Special		2
Total		528

One of the most important possibilities of locomotives equipped with superheaters has not received the attention it justly deserves; namely, the increased hauling capacity and the greater efficiency which can be obtained than from locomotives using saturated steam. There is no doubt that this is the most important feature of all, and while great economies in fuel and water are obtained, yet the fact that for a given weight of locomotives having a high factor of adhesion it is possible to make a machine of at least 20 per cent greater hauling power, overshadows all other considerations. This is a fact of obviously more importance than the mere question of economies in coal and water.

The most extensive discussion on the paper was presented by Mr. Vaughan as follows:—

The committee's report in connection with the coal-saving on the Canadian Pacific Railway is a little bit mixed. It gives 42 per cent in one case and 3 per cent in another. These figures are widely varying. I understand that they have been obtained by following two engines. I have always objected to following an individual engine. I do not think our coal records are kept with sufficient accuracy to make comparisons between two engines of any value, so I had the figures compiled for a number of engines, some of which had been converted from 10-wheel passenger engines which were originally built as simples. These engines have been running in and out lately on two divisions, and without any change whatever except with the addition of the superheater, which gives us a temperature from about 530 to 550 degrees. On our Quebec section the non-superheater engines used 2,500 tons of coal during the period for which the records were taken, and the superheater engines took 2,000 tons, so that it was a fairly good test, as it extended over three or four months. The saving in fuel was 15.5 per cent for the superheater over the non-superheater. On another section, involving rather less coal, the saving was 33 per cent. I consider that excessive, and possibly due to the engines on that section having been through the shop later, or something of the sort. I see very little reason for questioning the figures we have got, and believe that you can depend on a saving of 10 to 15 per cent in freight service and 15 to 20 per cent in passenger service, by the use of superheater locomotives.

In the use of superheaters in Europe, they reach temperatures up to 600 degrees and over. We are using temperatures of 520 to 580 degrees, what would be known in Europe as moderate superheat. If you want to get any real benefit from superheaters you must go to a reasonably high temperature. I would like to see all of our engines give a superheat of 550 degrees, and, if possible, a little more. When you go up to that temperature you get the real benefits from superheating. When you use 40 degrees, 50 degrees or 60 degrees of superheat you get a little better working engine, but you have not really got into the superheating business at all and are simply playing with it. You might as well get into the business and use a reasonable amount of superheat and get the results that are obtained from the use of a moderate or high degree of superheat on locomotives.

The statement has frequently gone out in newspapers and pamphlets to the effect that high superheating—and I believe these statements refer to what I call moderate superheating—involves a number of new processes in the locomotive, and increased cost of repairs, etc. According to our experience these statements are absolutely wrong. We have put superheaters on ordinary simple piston valve engines without any change whatever other than the putting of the superheater into the boiler, and we really find no difference in the maintenance of the engine, with one exception, and that is the renewal of the piston rings. We have to replace piston rings more frequently on the superheaters than on non-superheating engines. The difference is especially noticeable in bad water districts, where there is considerable foaming. Both the piston and the valve rings wear out more quickly under these conditions on superheaters than on non-superheaters. We get from a month to six weeks' service out of the rings in very bad water districts, while they average from two to three months in good water districts, and they run as high as twelve to fourteen months. I am of the opinion that the ring question is largely a question of material, and you can get from three to six months' service in ordinary water from piston rings in superheated locomotives.

The valve rings, which gave trouble on superheater locomotives, did not give trouble in good water districts. We run our valve bushings, as a rule through two shoppings, and the rings are frequently run from shopping to shopping without attention. In other words, there is very little difference between the valve rings on superheaters and the valve rings on non-superheater locomotives.

We are unable to furnish figures as to the actual cost of repairs, for the reason that we have no simple engines with which to compare our superheaters. Based upon the size of the engine, or the tractive power, the cost of repairs of the superheater engine has been decidedly lower than the cost of repairs of simple engines. I have always felt that that result was due to the superheater being applied to locomotives of more modern type, and, of course, newer engines than the saturated steam-engines, and consequently the figures were not reliable. I have, however, the cost figures for several months for these 10-wheel passenger engines equipped with the superheaters, and the cost for repairing superheater engines was only 3.47 cents a mile, and the non-superheater engines were 3.5 cents, so that the cost was practically identical.

That substantiates what we have always felt, and that is while there is a slight additional expense for the maintenance of superheater locomotives on account of piston rings, there is a slight gain from the fact that you are always working dry steam, and these two things offset each other to a large extent. The only real additional expense in superheaters is a periodical testing of the front end. Our regulations call for a testing every three months to see that everything in the front end is tight. I do not know that it is entirely fair to call that an additional expense, because I do not think it is a bad thing to test the front end of the locomotive, whether it has a superheater or not. It is simply taking a proper precaution instead of waiting for failure. Before we adopted this method of testing we used to run through the summer months very successfully, but when the hard winter weather came on we had complaints of the engine being short of steam. We usually found the steam pipe leaking, or something of that sort. By making a periodic test in a systematic manner you overcome that condition, and keep the engines in good condition right along. I believe there is money in doing this. Another expense is keeping the tubes clean. We clean out the fire tubes every round trip, and, as far as I know, that is carried out religiously. It is only a half-hour's work for a man, a cheap class of labor, and it is not a very great expense.

As far as lubrication is concerned, we notice very little difference in using sight-feed lubrication, between the superheater and the non-superheater. We do not use slide valves on superheaters. It has been tried many times, and in every case is is found to give trouble. You have practically got to put up with piston valves if you go to the superheater locomotive, and I do not know that there is very much objection to using piston valves.

I have had the mileage made by the superheater locomotives in passenger service on the Canadian Pacific, Eastern lines, recorded for March and April. There were 790,000 miles made in the passenger service, and there was not a failure due to superheaters. That is a pretty good proof that there is no need for failures due to superheaters, if you will keep after them. Last year I gave figures that showed that we made over two million miles, and that there was no failure due to a superheater, that is, a passenger failure due to superheater itself.

It is a certain amount of satisfaction to me to feel that when we went into this business first we were criticised for putting so much apparatus in the front end. During the past few years everybody's opinion seems to have changed on that, and there seems to be no objection to putting in two or three front ends and filling them with apparatus. We have used the intermediate superheater, by which I mean a boiler with an evaporating section at the back, the superheater in the middle. I won't say a feed water heater, but a front section into which the water is delivered. That engine was originally built as a reheater engine; in other words, the superheater was put in between the high and low pressure cylinders. We subsequently changed it over and put the superheater ahead of the high pressure cylinder. With the superheater acting as a reheater, we were getting ninety degrees superheat in the low pressure steam chests. With the superheater ahead of the high pressure, we obtained from 480 to 580 degrees in the high pressure steam chest; that is, a superheat of 100 to 200 degrees, varying, I think, according to the amount of water that was lifted by the engine, but we obtained very fairly uniformly 30 degrees of superheat in the low pressure steam chest. We didn't make any test on the two engines with the two arrangements. Our opinion was that it simply was not necessary. You could tell by the engine, by the fireman, that there was no comparison between the compound engine using the superheater ahead of the high pressure cylinder and one using no superheat in the high and superheat in the low. It made a different engine out of it. We shall not worry very much about experimenting with reheating. If you can run with 100 to 150 degrees of superheat on a high pressure cylinder, you are fairly safe in knowing that you are going to have a certain amount of superheat in the low pressure steam chest, and that there will be sufficient there to entirely avoid any water troubles in the low pressure cylinder. I feel that if we put in so much of a superheater that we get more superheat than we want in the high pressure steam chest, there is no advantage in going to reheating. We had better put all our heating surface where it does the most good.

I would like to ask Mr. Cole where he has proven that lowering the steam chest pressure is an advantage. I can see that lowering the boiler pressure is an advantage, if the boiler pressure is so high that you are having an abnormal amount of trouble with the boilers. We are running engines with two boiler pressures. In other words, we build a 21-in. engine with 200 lbs. pressure, and a 22½-in. engine with 175 lbs. pressure. We really set the pops at 180 on the lower pressure engine, to avoid the objection made by the engineers that they couldn't get the work out of the 175 lb. engine that they did out of the 200 lb. As a matter of fact, I think there was nothing to that, but their idea was that the more pressure they had, the more business they could do, it didn't make any difference what the size of the cylinder was. In order to avoid criticism, we gave the other engine 5 lbs. more so that she could pull just a little more. I watched those engines very carefully, and I do not see either theoretically or practically, any advantage whatever in reducing the boiler pressure unless you want to do it to save the boilers. In good water districts we certainly do not have trouble enough with the 200 lbs. pressure to make it any serious advantage to go to 180. In bad water districts we do notice a difference and we arrange to use engines with 175 or 180 lbs. pressure, but where you have reasonably good water, I fail to see any advantage whatever in reducing boiler pressures. I grant you that with superheated steam, you can reduce boiler pressures without losing efficiency, a thing that you could not do if you were using saturated steam; but I do not see any reason for obtaining greater efficiency, and I do feel most distinctly that the lower pressure engines, with bigger cylinders, are not as fast or as good as engines with the high pressure. I do not believe there is any difference in the pressure at the nozzle on either engine, and with the big cylinder you lose a greater percentage due to back pressure.

We have not built our passenger engines with 180 lbs. pressure, simply because we felt that a 200 lbs. engine was a faster and a better one. I have heard the statement made a number of times that you can obtain greater economy by reducing the boiler pressure, and I would like to know how it has been proved out, and why it is.

Other members reported satisfactory results with superheaters of various kinds.

Mr. Cole in answering Mr. Vaughan's question about low steam pressure stated that it was a matter of boiler repairs rather than a matter of superheating, in as much as any required temperature could be attained by the superheater in any case.

STEEL TIRES

Committee:—A. Stewart, chairman; A. S. Vogt, William Moir, E. D. Bronner, and H. D. Taylor.

The committee appointed to consider specifications for steel tires has been in communication with the tire manufacturers, some of the committee visiting the tire works with the idea of trying to work out specifications which it would be possible to enforce and not impose unnecessary hardships on the manufacturer or excessive cost to the purchaser. The results have not been encouraging, and we feel that any specification we could get up, to give any practical results, would require a test to destruction of at least one finished tire out of each heat. In view of the cost of carrying out a specification containing this requirement, we hesitate to offer it, and, unless it is the opinion of this Association that such a requirement, with the expense of enforcement, would be justified, we ask that the committee be discharged.

Discussion.—It was clearly brought out by the remarks of the members that by far the greatest trouble is being caused by tires under tenders. Very few reported any trouble with driving wheel tires, but practically every one that spoke had had difficulty with tender wheels.

Mr. Vaughan was not in favor of adopting a specification and his investigation of the subject showed that in many cases the trouble is due to the temperature at which the tire is finished. He was also of the opinion, although not positive, that the type of truck has some influence. On one very difficult division he had substituted the pedestal passenger type of truck for the previous diamond type and it greatly relieved the difficulty which, in his case, was confined almost entirely to service during the the winter months.

Other members who had tried Vanadium steel for tires reported that they had not been able so far to discover any increased wearing qualities, although their experience as yet had not been very extensive. Some members who had tried the 4 and 4½ in. tires reported them not as successful as the 3½ in. The character of the centre on which the tire is shrunk is also mentioned as having a considerable bearing on the life of the tire.

Upon motion, the report of the committee was received and referred to the executive committee for such action as they saw fit to take.

DESIGN, CONSTRUCTION AND INSPECTION OF LOCOMOTIVE BOILERS.

Committee:—Theo H. Curtis, Chairman; H. W. Jacobs, A. E. Manchester, D. R. MacBain, A. W. Gibbs.

The committee has not as yet had time to enable it to formulate rules and regulations covering the inspection of locomotive boilers, but it has thoroughly investigated the subject of boiler explosions and failures and casualties to employees and others resulting therefrom.

Blanks were forwarded to all of the principal railroads of the United States, asking for information in regard to boiler inspection rules and regulations and also as to casualties resulting from boiler explosions of all natures, and attention is called to the following information received in reports from 157 railroads replying to the question as to the number of boiler explosions and failures and casualties to employees and others resulting therefrom during the period from January 1, 1905, to November 1, 1909. These 157 railroads own and operate 43,787 locomotives and 157,169 miles of roadway, and during the period from January 1, 1905, to November 1, 1909, they made 6,012,057,467 locomotive miles. We estimate that there are about 58,000 locomotives in service in the United States; therefore, the reports which we have received cover about seventy-five per cent. of the total number of locomotives in operation in the United States.

Explosions and failures of locomotive boilers are divided into five classes, as follows:

Explosions of boiler shells,
Explosions of fire boxes,
Damage by burning,
Rupture of flues,
Boiler-fitting failures.

Explosions of boiler shells and fire boxes, or damage by burning, etc., are usually due to low water. Of the failures reported, 98.3 per cent. were due to low water and 1.7 per cent. to other causes.

Of the failures due to low water, 98.6 per cent. were due to the failure of the men handling or in immediate charge of the locomotive to maintain a proper supply of water in the boiler; the remaining 1.4 per cent. were due to other causes.

Automatic devices, either to maintain the water supply or to act as an alarm when proper supply is not provided, have been proposed and given consideration, but it has been determined that such devices are unreliable and have had the effect of taking away from the men in charge their accepted responsibility.

A statement of the explosions, failures and casualties is shown below:

	No.	Average per Year.	No. Killed.	Average per Year.	No. Injured.	Average per Year.
Low Water:						
Explosion of boiler shells.	14	2.9	20	4.1	16	3.3
Explosion of fire boxes...	246	50.9	127	26.3	144	29.8
Damaged by burning......	2,499	517.0	15	3.1	57	11.8
Ruptured flues	66	13.6	0	0.0	3	0.6
Fitting failures	25	5.2	0	0.0	4	0.8
Other Causes:						
Explosion of boiler shells.	6	1.3	10	2.0	7	1.4
Explosion of fire boxes...	2	0.4	1	0.2	1	0.2
Damaged by burning.....	40	8.3	1	0.2	1	0.2
Total	2,898	599.5	174	35.9	233	48.1

In the above table, of the 407 killed and injured, 386, or 94.8 per cent., were due to accidents caused by low water, while the remaining 21, or 5.2 per cent., were from other causes, some of these being the result of or incident to wrecks, and a small number are thought to be due to accidents caused by defects in design, material, workmanship or the physical condition of the boilers or fittings, but it is doubtful if any of them could have been prevented by any method of inspection in addition to that which is now in force.

In addition to the failures as shown above, there were also other failures, as follows:

	No.	No. Killed.	No. Injured.
Rupture of flues..................	3,204	8	21
Boiler fitting failures.............	1,609	2	51
Total	4,813	10	72

In analyzing the accidents due to the latter causes, attention is invited to the item of ruptured flues, shown to be 3,204. This, however, covers the record of an average number of 42,200 locomotives per annum for a period of four years and ten months. Assuming 250 flues to each locomotive boiler, the result shows one flue failure per year to each 15,912 flues in service, or, stated in other terms, the percentage of flue failures to the number of flues in service is six one hundred thousandths of one per cent.

Both of the above comparisons constitute an excellent endorsement of the present high standard of physical condition of American locomotive boilers, and show how small an opportunity there is to improve the present practice of railroads.

Of the 1,634 cases of boiler fitting failures reported, 1,609 are somewhat indefinite and apparently include failures occurring from causes other than the primary failure of the fittings, such as wrecks or other external accidents, many of them doubtless being of a minor character.

At the time the different railroad companies were asked for information as to boiler explosions, casualties, etc., they were also asked to supply copies of their rules and regulations for the care and inspection of locomotive boilers. A review of such rules and regulations as were submitted shows that a very thorough and vigorous inspection of locomotive boilers is being maintained and recorded, and the rules prescribe very thorough instructions as to the proper care of the locomotive boilers.

These rules and regulations plainly show that different localities require different rules and regulations for the care and inspection of locomotive boilers.

In some localities the water that is obtainable for use in these boilers is very detrimental to the boiler; therefore, very frequent inspections must be made, while in other localities the water conditions are very favorable and the period between inspections may be longer. In a general way, the rules and regulations for the care and inspection of the boilers must be made to meet the conditions under which the boilers are being operated, and no general rules will apply in a practical way.

From Senate Document No. 682, the following information was obtained: The average number of employees killed and injured per annum, on account of boiler explosions on locomotives, for the period from August 1, 1903, to November 1, 1908, was 49.7 employees and others killed and 134.2 injured. This Senate document covered a period of five years and three months and includes all the locomotives in use during that time.

During the period from January 1, 1905, to November 1, 1909 (four years and ten months), the replies from 157 railroads, having 43,787 locomotives, with a mileage of 6,012,057,467 miles, show that for said period the average number of employees killed and injured per annum was 38.0 killed and 63.1 injured. As the roads replying only represent about seventy-five per cent. of the locomotives in the country, it will be assumed that the figures represent about seventy-five per cent. of the casualties, which would make these figures approximate those furnished by the Government as to the number of persons killed and injured.

This report was given a very lively discussion, which, however, was of such a nature that a motion was carried to submit it to the executive committee before permitting its publication.

WIDENING GAUGE OF TRACKS AT CURVES.

Committee:—F. M. Whyte, Chairman; F. C. Cleaver, W. H. Lewis.

Various joint meetings have been held and the committee of this Association has from year to year reported progress to the convention. At the present time, however, it is possible to make the final report for your approval. The substance of the report was reported by the American Railway Engineering and Maintenance of Way Association, at their meeting last winter, and was adopted, so that, inasmuch as the subject interests that department more than it does the Motive Power department, it would appear to remain for this Association only to approve the report and the action taken. The recommendation is as follows:

"Curves eight degrees and under should be standard gauge. Gauge should be widened ⅛ inch for each two degrees or fraction thereof over eight degrees, to a maximum of 4 feet 9¼ inches for tracks of standard gauge. Gauge, including widening due to wear, should never exceed 4 feet 9½ inches.

"The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where unavoidable the above rule should be modified in order to make the gauge of the track at the frog standard."

On motion of Mr. Seley the report of the committee was adopted and the committee was discharged.

CONSOLIDATION.

The report of this committee is reprinted in abstract, in connection with the proceedings of the M. C. B. Association, on page 282 of the July issue.

Discussion.—Inasmuch as the M. C. B. Association has placed the report of the committee on the table for a year and referred the matter to the executive committee for an investigation of the legal features involved this association followed the same procedure.

CAR PERFORMANCE OF BEACH BATTERY CAR*

The following is the performance of the Beach Storage battery car from March 2 to June 2, 1910, on the 28th Street Crosstown Line in New York City, operating in passenger service with a regular schedule of 4.77 m. p. h., and 8 stops per mile between the east and west side ferries, and with only one battery charge per day. During this time there were no interruptions of service, the car operating in all kinds of weather with snow, sleet and rain. There were no repairs necessary except replacing one motor brush and replacing eight lamps.

Period of time, days	90
Condition of track	Very poor, no maintenance
Kind of rail	47 to 109 lbs.
Maximum grade, per cent	3½
Length of grade, feet	3,000
Number of curves per trip	46
Length of route, miles	4.77
Type of car	Single truck
Type of battery	Edison
Number of cells, driving	100, A-8
Number of cells, lighting	5
Mileage capacity of car per battery charge	86
Maximum speed, miles	15
Charging period of battery, hours	7 at 193.3 V., 30 Amp.
Seating capacity	26
Weight of car complete, lbs	10,000
Average load weight, lbs	2,400
Maximum number of passengers, 5-23-10	70
Average number of passengers	15
Car miles covered during the period	5,512.50
Car miles per day	57.25
Battery intake per day, watt hours	41,054
Current consumption per day at brushes, watt hours	25,453
Ave. current consumption per car mile based on battery intake, w. h.	717.80
Ave. current consumption per car mile at brushes, w. h	527.40
Ave. current consumption per ton mile based on battery intake, w. h.	99.70
Average current consumption per ton mile at brushes, w. h	73.20
Running speed between stops. m. p. h	5.74

* For general description see p. 194, May, 1910. The size of battery cells has been changed to A-8.

FORTY-FOURTH ANNUAL CONVENTION.

(CONTINUED FROM PAGE 288.)

TESTS OF BRAKE SHOES.

Committee:—W. F. M. Goss, Chairman; William McIntosh, J. R. Onderdonk.

In addition to its usual duty of investigating the properties of brake shoes, the committee has also been requested by the Executive Committee of the Association to consider and report upon the standards applying to brake beams. This report accordingly deals with both subjects.

BRAKE SHOES.

Routine Tests.—Since the presentation of its last report the committee has received from Mr. B. P. Flory, of the New York, Ontario & Western Railway Company, one brake shoe to be tested to determine its frictional qualities. The results of the tests are presented in Appendix C.

Researches of the Year.—Previous to 1907, the work of the committee consisted chiefly in determining the frictional qualities of brake shoes and in recommending specifications concerning their coefficients of friction. In 1907, and again in 1908, the researches of the committee were extended to include an investigation of the wearing qualities of shoes. In the reports of 1907 and 1908 there are presented certain data concerning the wear of shoes which, however, were not considered sufficient to warrant any recommendation concerning a specification with respect to wear, the chief lack being in any information concerning the effect of the shoes upon the wheel itself. To supply this deficiency, a wheel scale, referred to in the report for 1909, was purchased, and has been in operation during the current year. By its use, it has been possible to determine the loss of weight in the wheel under the action of the shoe, as well as the loss in the shoe itself.

In pursuance of the program outlined in previous reports and approved by the Association, the committee at the beginning of last year selected from cars in service twenty-eight brake shoes which are believed to be representative of the shoes now in use on the railways of the country. These twenty-eight shoes are of fourteen different kinds, each kind in duplicate. One set of fourteen shoes was submitted to the tests outlined below in the Master Car Builders' laboratory at Purdue University. The other set was tested upon the brake-shoe testing machine of the American Brake Shoe and Foundry Company, at Mahwah, New Jersey. A list of these twenty-eight shoes is given in Table 1, which also presents their trade names and other information.

SERIAL NO.	PURDUE LABORATORY NO.	DESIGNATION	OBTAINED FROM	MARKS FOUND ON SHOE
1	2	3	4	5
1	281	PLAIN CAST IRON	TRUCK IN C & N W SHOPS	C & N W 8386
2	282		" " " "	C & N W 8386 (NO NOT CLEAR)
3	283	PLAIN CAST IRON - WITHOUT REINFORCEMENT	C. & N. W. CAR NO 52327	2100 C
4	284		C & E I. CAR NO 61561	5170
5	285	CONGDON 7 INSERTS	TRUCK IN C & N W SHOPS	C. & N W 8386
6	286		" " " "	C & N W 8386 - 1
7	287	CONGDON - STEEL BACK 5 INSERTS	C. & N W CAR NO 9512	C C 2 & G
8	288		C & N W CAR NO 10356	C C 2 & G
9	289	STREETER - STEEL BACK	I. C. CAR NO. 23572	(NONE FOUND)
10	290		C & N W CAR NO 8460	(NOT DISTINGUISHABLE) & Ⓢ
11	291	LAPPIN - CHILLED ENDS	C & N W CAR NO 95526	[Ⓛ] 4 1193 FREIGHT NYC LINES
12	292		" " " "	[Ⓛ] 4 1193 FREIGHT NYC LINES
13	293	LAPPIN - CHILLED ENDS	C & E I CAR NO 587	[Ⓛ] 4 1193 FREIGHT NYC LINES
14	294		NYC H R CAR NO 69732	N Y C LINES FREIGHT
15	295	PLAIN CAST IRON - STEEL BACK	F W SARGENT, AMER B S & F CO	(NOT NOTED)
16	296		" " " " "	PATENTED D 3 N-5470-4-1193
17	297	COLUMBIA	B D LOCKWOOD - FROM C H & D CAR	(NOT NOTED)
18	298		" " " " "	C H & D 1507
19	299	DIAMOND S - STEEL BACK	WM MCINTOSH - FROM C R R N J STOCK, APPLIED IN SERVICE THEN REMOVED	[◇S] G 724 4
20	300		DITTO	[◇S] G 724 4
21	301	WALSH	J A SPOOR OF THE CHICAGO JCT RY	(PRICK PUNCHED) C J
22	302		" " " " "	(PRICK PUNCHED) C J
23	303	PITTSBURG - MALLEABLE SHELLS	E F NEEDHAM OF THE WABASH R R	PITTSBURG BRAKE SHOE CO PITTSBURG PA
24	304		" " "	PITTSBURG BRAKE SHOE CO PITTSBURG, PA
25	305	PITTSBURG - STEEL SHELLS	" " "	PITTSBURG CO BRAKE SHOE, PITTSBURG, PA
26	306		" " " " "	PITTSBURG CO BRAKE SHOE
27	307	NATIONAL	W R BUCK OF THE A T & S F RY	(NOT DISTINGUISHABLE)
28	308		" " " "	38 (NO NOT CLEAR)
14 SHOES WITH EVEN SERIAL NOS SENT TO PURDUE UNIVERSITY LABORATORY 14 " " ODD " " " AMER BRAKE SHOE & FOUNDRY CO				

TABLE I.—INFORMATION FOR SHOES USED IN TEST.

These shoes have been tested under the following schedule:

- A. Tests to determine the coefficient of friction of the shoe under the current specifications.
- B. Tests to determine the loss in weight of the shoe under repeated applications.
- C. Tests to determine the loss in weight of the wheel under the repeated application of the shoe.

The fourteen shoes submitted to the Master Car Builders' laboratory at Purdue University were subjected to the entire schedule. The detailed report submitted by the authorities of Purdue University is included as Appendix A (not reproduced here). The shoes submitted to the American Brake Shoe and Foundry Company were tested only for coefficient of friction, and the report of these tests is included as Appendix B (not reproduced here).

COEFFICIENT OF FRICTION

Each of the twenty-eight shoes has been tested to determine its coefficient of friction under the current specifications of the Association. The coefficient of friction has been determined on a cast-iron chilled wheel in effecting stops from an initial speed of forty miles per hour under three brake-shoe pressures, namely, 2,808, 4,152 and 6,840 pounds. The coefficient of friction has been determined on a steel-tired wheel in effecting stops from an initial speed of sixty-five miles per hour under shoe pressures of 2,808, 6,840 and 12,000 pounds. The fourteen shoes sent to the American Brake Shoe and Foundry Company were also tested on the steel-tired wheel under intermediate and higher pressures.

The results of these tests, which are included in the reports of Purdue University and the American Brake Shoe and Foundry Company, have been summarized and are displayed in Table 2.

The coefficients of friction obtained by the American Brake Shoe and Foundry Company on their testing machine are, at the lower pressures, about the same as those obtained upon the Master Car Builders' standard machine; but at the higher pressures they are considerably lower. The explanation for such differences probably lies in the fact that the flywheel of the former machine is heavier and has, at a like speed, greater kinetic energy than the flywheel of the standard machine. As a result of this, the stops made with the former machine are longer and result in greater heating of the shoe. Because of this difference in the construction and in the characteristics of the two testing machines, the committee has limited its consideration to the results obtained in the laboratory of the Association at Purdue University, in determining upon its recommendations concerning coefficients of friction.

From its consideration of the results obtained upon the cast-iron wheel the committee has decided to recommend that shoes when tested upon a cast-iron wheel, in effecting stops from an initial speed of forty miles per hour, shall develop a mean coefficient of friction of not less than

22 per cent. when the brake-shoe pressure is 2,808 pounds.

16 per cent. when the brake-shoe pressure is 6,840 pounds.

The only change from the current specification involved in this recommendation is the omission of the specification at the intermediate pressure of 4,152 pounds. With rare exceptions, the shoe which meets the specifications at the two pressures stated will also meet them at the intermediate pressure, and the test at the third pressure is, therefore, considered to be unnecessary.

The current specifications require shoes to be tested on the steel-

TABLE 2

THE MEAN COEFFICIENTS OF FRICTION DEVELOPED BY EACH OF THE SHOES ON BOTH THE CAST IRON WHEEL AND THE STEEL-TIRED WHEEL

SHOE NUMBER	LABORATORY AT WHICH THE TEST WAS MADE	MEAN COEFFICIENT IN PER CENT. INITIAL SPEED OF 40 M P H CAST IRON WHEEL SHOE PRESSURE-LBS.			MEAN COEFFICIENT IN PER CENT STOPS FROM AN INITIAL SPEED OF 65 M.P H STEEL-TIRED WHEEL SHOE PRESSURE — LBS						
		2808	4152	6840	2808	4152	6840	10000	12000	15000	18000
281	A.B.S.&F.Co.	26 3	21.7	21.0	16 3	13.1	11.0				
282	PURDUE	22.1	21.6	20.4	16 0		12.4		10.4		
283	A.B.S.&F.Co.	25.1	23.5	20.6	—	—	11.7				
284	PURDUE	30.3	27.7	24.5	16.3		13 5		11.6		
285	A.B.S.&F.Co.	26.8	19.0	15.3	19.7	17 7	12 4	8.9	9.4	8.1	7.7
286	PURDUE	22.2	19.8	16 4	20.6		14.0		11.3		
287	A.B.S.&F.Co.	25.0	18.3	17.2	20.3	18.0	11.8	9.5	9.8	8 5	7 6
288	PURDUE	24.4	22.6	19.1	15.1		11.9		11.7		
289	A.B.S.&F.Co.	24.5	22 6	19.0	16.9	14 9	11.1	11.7	10.4	9.5	9.1
290	PURDUE	21.3	20.6	16.4	13.6		10.8		10.7		
291	A.B.S.&F.Co.	18.2	16.8	16.1	15.0	13.4	10.1	8.8	6.6	8 8	6.8
292	PURDUE	20.5	19.6	18.9	17.0		13.0		11.1		
293	A.B.S.&F.Co.	20.5	18.4	14.3	16.3	15.1	11.6	9.1	9.3	7.9	6 6
294	PURDUE	18.4	17.8	17.5	16.9		12.7		12.2		
295	A.B.S.&F.Co.	27.0	25.1	21.9	16 9	13.5	11.3	9 7	8.4	9.3	8.5
296	PURDUE	21.0	20.3	18.5	16.2		13.2		11.1		
297	A.B.S.&F.Co.	27.0	28.6	21.8	18.4	14 0	13.5	—	--	—	—
298	PURDUE	21.0	18.9	17.3	16.8		13.1		10 7		
299	A.B.S.&F.Co.	24.2	20.0	16.2	21.5	17.4	13.5	11.2	10.8	9.8	9.8
300	PURDUE	22.8	20.5	18.3	17.3		13.6		12.3		
301	A.B.S.&F.Co.	22.6	20.0	14.9	14 7	12.1	10.3	8.7	8.6	9.1	8.7
302	PURDUE	23.7	20.5	19.8	16.6		14.4		11.5		
303	A.B.S.&F.Co.	24.4	21.9	17.0	17.7	17.9	17.5	14.0	11.8	11.2	10.7
304	PURDUE	26.8	25.4	21.5	22.8		18.9		17.6		
305	A.B.S.&F.Co.	29.9	29.6	24.2	23.0	20.9	18.7	15.8	14.7	14.2	15.3
306	PURDUE	29.4	27.5	23.4	25.8		23.2		22.2		
307	A.B.S.&F.Co.	16.3	15.2	11.9	15.1	11.3	9.8	8.2	7.5	6.9	8.3
308	PURDUE	19.3	16.4	14.3	15.2		12.1		11.2		

B. On the steel wheel.—At a constant speed of 20 miles per hour and at a shoe pressure of 2,808 pounds.

C. On the steel wheel.—In effecting stops from an initial speed of 65 miles per hour and at a shoe pressure of 12,000 pounds.

During the tests at the lower pressure (conditions A and B) most of the shoes were applied 300 times to the wheel, while the latter was kept running at a constant speed of twenty miles per hour. A few of the thinner shoes were given only 200 applications, and in one case 100 applications only were made. These applications of the shoe to the wheel were made by means of an automatic device on the testing machine which operates to keep the shoe in contact with the wheel for about one minute, while the interval between contacts is about three minutes. At the end of each 100 applications, both the shoe and the wheel were weighed to determine the metal lost by abrasion.

The tests on the steel wheel at the higher pressure (condition C) were made by a process similar to that employed in determining the coefficient of friction. In most cases, nine stops were made from an initial speed of sixty-five miles per hour, after which both the shoe and the wheel were weighed to determine their loss. With two of the shoes, the number of stops was reduced to six instead of nine.

The results of the tests to determine shoe wear are summarized in Table 3, and the results of the wheel-wear tests are shown in Table 4.

Results of the Tests on Wheel Wear.—At a shoe pressure of 2,808 pounds, the only shoe which produced an appreciable wear on the cast-iron wheel is the Congdon shoe, No. 286. It is somewhat significant that this is the shoe showing the least shoe wear. During the tests on the steel wheel, at a pressure of 2,808 pounds, only two shoes caused any considerable wear of the wheel. These are numbers 286 and 288, both Congdon shoes. Shoe 286, which was given 300 applications to the wheel, cut four V-shaped grooves about 1-32 inch deep and several smaller ones around its entire circumference. Shoe 288 had scored the wheel in a similar manner with five grooves after 100 applications. During the tests on the steel wheel at a pressure of 12,000 pounds, only two shoes produced any wear whatever on the wheel, and this was quite inconsiderable in amount. These shoes are Nos. 304 and 306, both Pittsburgh composition shoes. These two, however, did not score the wheel.

tired wheel at three different pressures. For the reasons just stated, the committee believes that tests under two pressures will be sufficient. In order to have the test conditions more nearly like those which prevail in practice, it seems desirable that the higher of these two shoe pressures should be 12,000 pounds. The committee accordingly recommends that shoes, when tested upon a steel-tired wheel, in effecting stops from an initial speed of sixty-five miles per hour, shall develop a mean coefficient of friction not less than

12½ per cent. when the brake-shoe pressure is 6,840 pounds.

11 per cent. when the brake-shoe pressure is 12,000 pounds.

This recommendation involves dropping from the current specifications the tests at pressures of 2,808 and 4,152 pounds and substituting therefor a test at a pressure of 12,000 pounds. The test at 6,840 pounds shoe pressure is retained; but the coefficient is increased from 12 per cent. to 12½ per cent.

The Association has, for some years, specified that the rise in the coefficient of friction at the end of a stop should not exceed 7 per cent. The experience of the laboratory during the past four or five years indicates that a shoe which meets the specification concerning the *mean* coefficient also generally meets this requirement concerning the final coefficient. Whenever a shoe develops a final coefficient of friction in excess of the specifications it does so only within 4 or 5 feet of the end of the stop; and it is not likely, therefore, to have any harmful effect in service. For these reasons the committee believes that the specification concerning final coefficient of friction may properly be omitted from the standards of the Association, and it so recommends.

SHOE WEAR AND WHEEL WEAR.

Each of the fourteen shoes submitted to the laboratory at Purdue University was tested to determine its wear under repeated applications to both the cast-iron and the steel-tired wheel under the conditions cited below. Under these same conditions, the loss in weight of the wheel under the action of the shoe was determined by means of a scale especially designed for the purpose, which was referred to in last year's report. The shoe wear and wheel wear tests were run under the following conditions:

A. On the cast-iron wheel—At a constant speed of 20 miles per hour and at a shoe pressure of 2,808 pounds.

TABLE 3.—TEST TO DETERMINE SHOE WEAR.

SHOE NUMBER	DESIGNATION OF THE SHOE	LABORATORY AT WHICH THE TESTS WERE MADE	WHEN TESTED ON THE CAST IRON WHEEL SHOE PRESS-2808 LBS. NUMBER OF APPLICATIONS	SHOE LOSS IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE	WHEN TESTED ON THE STEEL-TIRED WHEEL SHOE PRESS 2808 LBS NUMBER OF APPLICATIONS	SHOE LOSS IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE	SHOE PRESS-12000 LBS NUMBER OF APPLICATIONS	SHOE LOSS, IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE
282	PLAIN CAST IRON	PURDUE	400	745	300	856	9	1 917
284	PLAIN CAST IRON WITHOUT REINFORCEMENT	PURDUE	300	1.225	100	1.360	9	3 135
286	CONGDON	PURDUE	200	.163	300	.706	9	1.467
288	CONGDON — STEEL BACK	PURDUE	300	.212	100	633	9	1 405
290	STREETER — STEEL BACK	PURDUE	300	.433	300	.482	9	2 240
292	LAPPIN — CHILLED ENDS	PURDUE	300	592	300	.885	9	3 405
294	LAPPIN — CHILLED ENDS	PURDUE	300	572	300	.590	9	2 820
296	PLAIN CAST IRON STEEL BACK	PURDUE	300	820	300	1.058	9	3 833
298	COLUMBIA	PURDUE	100	537	100	.592	9	1.594
300	DIAMOND S STEEL BACK	PURDUE	300	565	300	.662	9	2 925
302	WALSH	PURDUE	300	671	300	.784	9	8.780
304	PITTSBURG MALLEABLE SHELL	PURDUE	200	.292	200	.273	6	.705
306	PITTSBURG STEEL SHELL	PURDUE	200	239	200	.299	6	.918
308	NATIONAL	PURDUE	300	.396	300	.413	9	2 565

TABLE 4

RESULTS OF THE TESTS MADE TO DETERMINE WHEEL WEAR AT THE LABORATORY OF PURDUE UNIVERSITY.

		CAST IRON WHEEL		STEEL-TIRED WHEEL			
			SHOE PRESS.-2808LBS		SHOE PRESS-2808LBS		SHOE PRESS-12000LB
SHOE NUMBER	DESIGNATION OF THE SHOE	NUMBER OF SHOE APPLICATIONS	WHEEL WEAR IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE BY SHOE	NUMBER OF SHOE APPLICATIONS	WHEEL WEAR IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE BY SHOE	NUMBER OF SHOE APPLICATIONS	WHEEL WEAR IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE BY SHOE
282	PLAIN CAST IRON	400	0.0004	300	0 0046	9	NONE
284	PLAIN CAST IRON	300	NONE	100	NONE	9	"
286	CONGDON	200	0 0859	300	0.1685	9	"
288	CONGDON	300	0 0063	100	0 2330	9	"
290	STREETER	300	NONE	300	0 0192	9	"
292	LAPPIN-CHILLED ENDS	300	"	300	0 0003	9	"
294	LAPPIN-CHILLED ENDS	300	"	300	NONE	9	"
296	PLAIN CAST IRON	300	"	300	NONE	9	"
298	COLUMBIA	100	"	100	0.0123	9	"
300	DIAMOND S	300	"	300	0.0016	9	"
302	WALSH	300	"	300	NONE	9	"
304	PITTSBURG-MALL. SHELL	200	0.0045	200	0.0209	6	0 0940
306	PITTSBURG-STEEL SHELL	200	0.0026	200	0.0192	6	0.1148
308	NATIONAL	300	NONE	300	0.0242	9	NONE

Conclusions Concerning Wheel Wear.—The results seem to warrant the conclusion that none of the ordinary shoes in service are likely to cause any appreciable wear on the cast-iron wheel. The wear on the steel wheel, while greater than on the cast-iron wheel, is likewise almost inconsiderable, except in the case of the two insert shoes above cited. The committee regards the scoring of the wheel in these two cases as more or less accidental, and experience with insert shoes in service seems to warrant this opinion. After consideration of all the facts here presented, the committee has concluded that no serious wear of the wheel is to be expected from the action of any of the shoes now in ordinary service, and it, therefore, considers any recommendation concerning wheel wear to be unnecessary.

The committee regards the reassurance which proceeds from such conclusions as ample return for the effort and expense which have been entailed by its research concerning the effect of brake shoes upon the wheel. Such conclusions also clear the way for a recommendation concerning the wear of the shoes themselves, which, until now, the committee has felt unable to make.

Results of the Tests on Shoe Wear.—The wear is represented in terms of weight lost by the shoe per 100,000,000 foot-pounds of work done. These weights may be accepted as measures of the relative durability of all of the shoes except the composition shoes, Nos. 304 and 306. The density of the shell and filler of these two shoes is less than that of the metallic shoes in the ratio of 1 to 2.4. To compare the durability of these shoes with the durability of the others, their actual loss in weight should, therefore, be multiplied by 2.4.

The facts may be generalized as follows:

a. The shoes tested present great variation in their wearing qualities, the ratio between the poorest and the best shoe being as great as 1 to 6.

b. The relative resistance to wear exhibited by different shoes is somewhat affected by the severity of the application. Of a series of shoes, the one which suffers least from wear at light pressures may not be the one which suffers least under a heavy pressure.

c. All shoes tested wear more rapidly on a steel-tired wheel than on a cast-iron wheel, when tested under like pressures.

d. In general terms, it may be stated that the shoes which show a wear greatly below the average are those which cause wear in the wheel.

e. All shoes show greater wear, per unit of work performed, when applied under the higher pressure. The ratio is occasionally as great as 1 to 10.

Recommendations Concerning Shoe Wear.—The committee recommends:

That on the cast-iron wheel the shoe wear be determined by making 100 applications of the shoe to the wheel, under a pressure of 2,808 pounds, and at a constant wheel speed of twenty miles per hour; at each application the shoe to be in contact with the wheel during 190 revolutions and out of contact during the succeeding 610 revolutions.

That, under these conditions, the shoe shall lose in weight not more than 0.8 of a pound for each 100,000,000 foot-pounds of work done.

That, on the steel-tired wheel, the shoe wear be determined by making ten stops from an initial speed of sixty-five miles per hour, and under a shoe pressure of 12,000 pounds.

That, under these conditions, the shoe shall lose in weight not more than 4.0 pounds for each 100,000,000 foot-pounds of work done.

That, in the case of non-metallic shoes, these limits of wear be reduced in the ratio of the density of their abraded parts to the density of cast iron.

Only one of the shoes tested on the cast-iron wheel and one of those tested on the steel wheel fail to meet the proposed specification. The shoes which develop a high coefficient of friction are also those which are likely to show the greater wear,

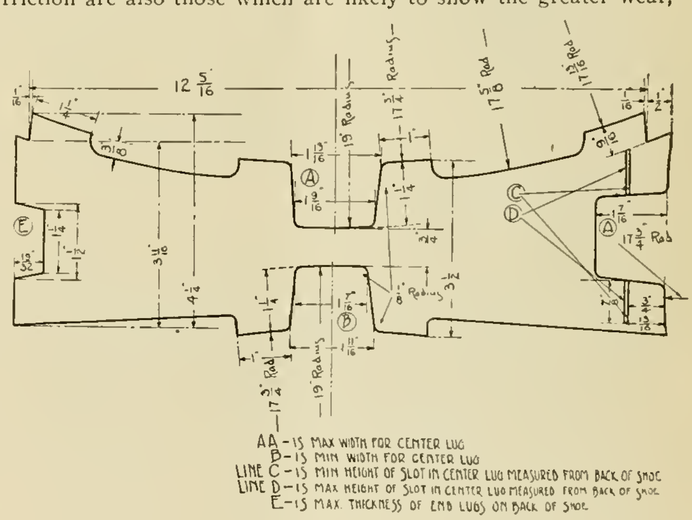


FIG. I.

and if, therefore, the proposed wear limits are made more exacting than is here proposed, almost all of the shoes which pass the specifications for coefficient of friction would be rejected under the specifications for wear.

For these reasons, the committee concluded that the wear limits should not be made more exacting than is proposed in the recommendations above; and it believes that the proposed wear specifications, when combined with the specifications concerning coefficient of friction, will serve their main purpose of protecting the purchaser against the unusually soft shoe.

SHOE GAUGE AND THICKNESS OF INSERTS.

Shoe Gauge.—The Association has a standard gauge for the brake head. Since the back of the shoe must fit this head, the committee believes that a limit gauge for the back of the shoe ought also to be added to the standards, and it proposes for this purpose the gauge shown in Fig. 1.

Thickness of Inserts.—In many insert shoes the inserts are so thin that they are either worn through or drop out during the first quarter of the life of the shoe. The committee believes that inserts should be made as thick as the processes of manufacture will permit, and it recommends that in no case should the thickness of the insert in the new shoe be less than one-half of the total depth of the shoe.

BRAKE BEAMS.

After a study of all previous actions, the committee decided to limit its consideration of changes in standards to—(1) size of the hanger hole in the brake head, (2) certain changes in the specifications for beam tests, and (3) limiting dimensions governing the outline for brake beams. Suggestions concerning the three items were embodied in a circular of inquiry which was sent to the members in January.

The committee has invited the manufacturers of brake beams to send representatives to its meetings, and representatives of the following companies have been present during certain of its discussion:

The American Steel Foundries.
The Chicago Railway Equipment Company.
The Damascus Brake Beam Company.
The Davis Brake Beam Company.

The suggestions made by these representatives have been given due consideration along with the replies received to the circular of inquiry.

Brake Head Hanger Hole.—In the circular it was proposed to increase the size of the hanger hole sufficiently to permit the use of a 1-inch hanger as well as the ⅞-inch hanger. The change was suggested on account of the breakage of the ⅞-inch hanger under some conditions of service. To the inquiry on this point seventeen replies were received, twelve of which advocated the proposed change. In the five other replies the change is opposed only on account of the increased play which would be allowed when a ⅞-inch hanger would be used in the larger hole. In some of these replies the ⅞-inch hanger is held to be sufficiently strong, especially if it be made with a larger fillet at the bend than is at present customary. After considering all the replies, the committee has decided to recommend the proposed change, and it believes that the edges of the hole ought also be rounded out to permit the use of a filleted hanger. It, accordingly, recommends that the present standard brake head be so

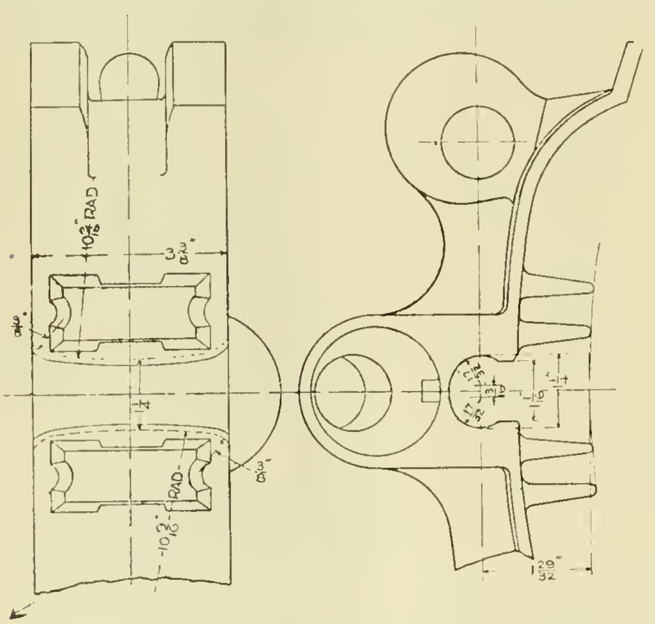


FIG. 2.

modified as to conform in these respects to the head shown in Fig. 2.

Specification for Tests.—The committee has reconsidered the current test specifications, and it believes that changes are desirable in the two respects referred to below.

The present specifications require that, as a preliminary to the deflection tests for both the No. 1 and the No. 2 beams, a load of 6,000 pounds be applied and then released; after which the load for producing deflection is applied. The committee believes that the preliminary load for the No. 1 beam should be reduced to 4,000 pounds, and it so recommends. It is thought that the change will result in more careful assembling of the beam.

The current specifications require no test for the ultimate strength of the beam. On account of the diversity in beam designs the deflection test gives but little information concerning their ultimate strength. The committee, therefore, considers it desirable that the beam be finally tested to destruction, and that under this test the maximum load borne shall not be less than

20,000 pounds for the No. 1 beam,
38,000 pounds for the No. 2 beam,

and it recommends that such tests be added to the specifications.

Paragraph 2, under "Brake Beams," on page 590 of the Proceedings for 1909, is in conflict with the test specifications. The committee recommends that it be omitted.

Brake-beam Limit Outline.—In its circular, the committee proposed the establishment of an outline which should serve to limit the dimensions of the beam. The purpose of the suggestion is to

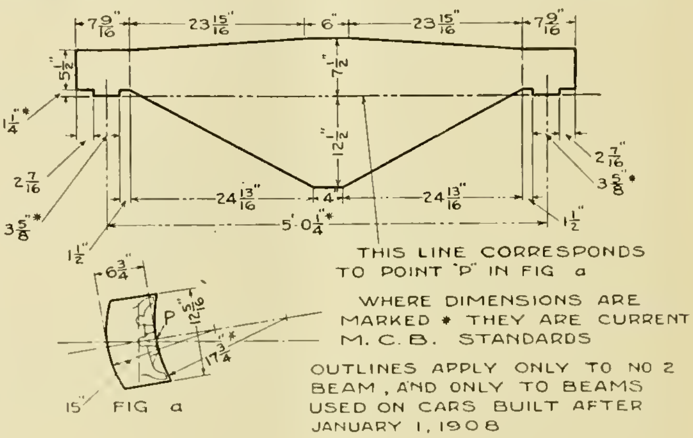


FIG. 3.

facilitate replacements of beams on cars in interchange. To the inquiry on this matter fifteen replies were received, in none of which was the feasibility of establishing such a limit called in question. The beam manufacturers have likewise endorsed the proposal. After consideration of the replies received from the railway companies and of the dimensions submitted by the manufacturers, the committee has prepared the outline which is represented in Fig. 3. It recommends that the Association adopt as a standard this outline within which all parts of the No. 2 beam must fall, it being further understood that the recommendation is to apply only to beams used on cars built after January 1, 1908.

Use of the No. 2 Beam.—The committee believes that the use of the No. 2 beam should be required on cars of more than 35,000 pounds light weight. The current standards are open to misrepresentation at this point. It, accordingly, recommends that the paragraph on page 591 of the Proceedings for 1909, which reads, "Beam No. 2 to be suitable for cars exceeding 35,000 pounds light weight," be changed to read: "Beam No. 2 must be used on cars of more than 35,000 pounds light weight, and it may be used on cars of 35,000 pounds light weight or less."

An Editorial Change in Current Standards.—On page 591 of the Proceedings for 1909, the last paragraph under the heading "Brake Beam Specifications and Tests" reads as follows: "On cars built after September 1, 1909, it will not be permissible to hang brake beams from any portion of the body of the car." The committee believes that this statement would more appropriately appear under the heading of "Brake Beams" in the preceding section, and recommends that it be shifted to that place.

Inside Hung Beams.—The Committee on Brake Beams, reporting in 1906, suggested for recommended practice that "all beams be inside hung." The whole report of this brake-beam committee was referred to the Committee on Standards, who, reporting in 1907, approved the recommendation noted above, provided it were construed as not requiring outside hung beams then in service to be changed.

All other recommendations of the Committee on Standards, except this one item, were submitted to letter ballot in 1907. There is nothing in the discussion before the convention to warrant this omission from the ballot, and that it was not there included is probably due to an error. Your committee, therefore, recommends that this provision be restored to the recommended practice of the Association.

Discussion—Mr. Burton asked for information concerning the coefficient of friction and wear resulting from continuous contact between the shoe and wheel in heavy grade service. Prof. Schmidt, who, in the absence of Dr. Goss, presented the committee's report, answered by saying that while no tests had been made directly covering this feature, there was no question but what the coefficient of friction decreased as the shoe got hot.

Mr. Young asked for information concerning the question of brake shoes on steel or steel tired wheels in freight service. He also drew attention to the fact that this committee gave results from 12,000 lbs. brake shoe pressure, while the committee on brakes recommended 18,000 lbs. shoe pressure. Prof. Schmidt stated that the results for 12,000 lbs. would hold for 18,000 lbs. shoe pressure. He also said that the results on steel tired wheels in the report he thought would cover freight service as well as passenger.

The committee's report, as far as it refers to brake shoes, was then ordered to be referred to letter ballot.

The section of the report dealing with brake beams was amended by Mr. Seley, allowing a slight variation from the .0625 inch deflection permitted, and in that form was ordered submitted to letter ballot.

SPLICING UNDERFRAMING.

Committee:—R. E. Smith, Chairman; W. F. Bentley, I. S. Downing, H. L. Trimyer, F. A. Torrey.

The committee was continued from last year to investigate the following subjects:

(a) Maximum amount of sill splicing allowable, as referred to in Rule 65 of the Rules of Interchange.

(b) Strength of various forms of underframing.

RECOMMENDATIONS

A. Maximum amount of sill splicing allowable, as referred to in Rule 65 of Rules of Interchange:

1. That M. C. B. Rule 65 be changed to read as follows:

"Draft timbers must not be spliced. Longitudinal sills may be spliced at two points. No adjacent sills, except center sills, to have entire splice immediately opposite the splice on adjacent sill; splices to be staggered so as to make joint of one splice at least 24 inches from the joint of the splice on adjacent sill, measured from a line drawn at right angles with sills. Center sills must be spliced between body bolsters and cross-tie timbers, but not within 18 inches of either. Splices on all sills other than center sills, as provided for above, can be located at any point between body bolsters or between body bolster and end sill, but not within 12 inches of body bolster.

"When splicing longitudinal sills the plan shown in Fig. 9-B is to be followed.

"Any sill spliced after September 1, 1910, that does not conform to the above, will be considered improper repairs.

"Steel sills may be spliced in the most convenient location, in accordance with Figs. A, B and C. Adjacent steel sills may be spliced. The thickness of each splice must not be less than the thickness of the web of the section spliced."

2. That all figures showing plans for splicing wood sills in M. C. B. Rules be eliminated, except Fig. 9-B.

An analysis of the proposed rule will show that few restrictions have been placed upon the practice of economy in the use of high-grade material, which is rapidly becoming more costly and difficult to obtain; we do not feel that we have recommended too wide a latitude in the number of location of the splices.

It has, of course, been impracticable for the committee to conduct practical tests to demonstrate the soundness of its recommendations, because of the large scale upon which such tests would have to be conducted; and it is questionable whether the testing to destruction of any reasonable number of cars, with sills spliced in a variety of ways and locations, would conclusively confirm or disprove any theory or afford positive data from which to prescribe correct practice. There remained then, only judgment and experience upon which to base our recommendations, which are respectfully submitted.

STRENGTH OF VARIOUS FORMS OF UNDERFRAMING

As far as the committee has been able to go into the matter, it appears that there is but a small percentage of the total equipment of the country provided with partial metal underframes or subframes; that there is a clear distinction between cars with metal underframes, provision for which is distinctly made in Rule 113, and cars with partial metal underframes or subframes; in the former case the entire underframe is of steel, with superimposed or attached timbers of light section, serving merely as a means of securing the superstructure to the steel frame; in the latter case the partial metal underframe is really a subframe upon which the heavy longitudinal sills rest; or it may consist merely of two longitudinal members, placed parallel with or replacing the draft sills, and serving as a more substantial means of securing the draft rigging; in some designs the body bolsters are found riveted up with the frame; in others with the metal cross ties; in still others with both bolsters and cross ties; some are designed to dispense with the body truss rods; they are not in a strict sense car frames, but rather a form of continuous draft gear to which it has been found convenient to attach the body bolsters and cross ties. Some designs are patented, and the prices range between $40 and $300.

The committee is of the opinion that this form of rebuilding is not going to be extensively used. If it should, the question of the proper basis of settlement for cars so equipped, when destroyed on a foreign line, will become more pressing than it is to-day.

The committee does not feel that it can, at this time, make a recommendation as to the amount that should be allowed for each design that has come under its notice, and it does not believe that it has seen all designs now in use; nor can it suggest an allowance that would represent a fair average for all designs. The committee is of the opinion that the allowance of $40, provided in present Rule 113, is not excessive for any of the designs.

The report was referred to the arbitration committee to be considered next year.

TRAIN LIGHTING.

Committee:—T. R. Cook, Chairman, E. A. Benson, Carl Brandt, Ward Barnum, J. H. Davis.

The committee desires to suggest as recommended practice the following points:

(1) That each electrically lighted car be provided with a notice describing the apparatus in the car, in accordance with Fig. 1, and that this notice shall be posted in a conspicuous

A. B. C. R. R. CO.
ELECTRIC LIGHTING

System ....
No. cells in series...
No. sets in parallel...
Amp. hrs. capacity of battery (at 8 hrs. rate)......................
Normal charging rate.......................Max.................
Size of train line wires......................................
Amp. discharge full light.....................................
Setting Axle generator.......................................
Cut in voltage...
Amperes no light...
Amperes full light...
Axle pulley diameter...
Generator pulley diameter....................................

WIRING DIAGRAM
Show Capacity of Fuses

FIG. 1.

place in or near the switchboard locker.

(2) That where train line connectors are used, Gibbs' No. 3-G Train Line Connector be used, located as shown on Fig. 2,

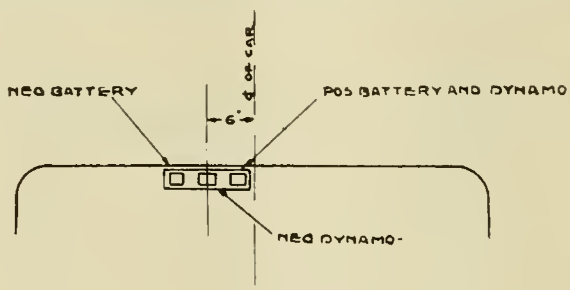


FIG. 2.

with connections to the battery, dynamo and jumper, as shown on Fig. 3.

(3) That batteries shall be connected up with the positive to the right, facing the car, as shown on Fig. 3.

(4) That where double compartment tanks are used, the connections and arrangement of battery terminals are to be as shown on Fig. 4.

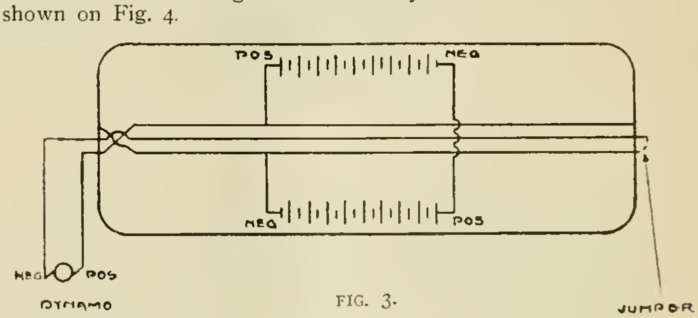


FIG. 3.

(5) That each electrically lighted car shall be provided with two charging receptacles with swivel supports, installed one on each side of the car, as shown on Fig. 5.

(6) That each electrically lighted car be provided with two 150 ampere fuses, close-connected to each battery terminal; the fuses to be arranged and placed in a cast-iron box, and installed on car, as shown on Fig. 5.

(7) That each electrically lighted car shall have provided on the switchboard in the car a switch, fused switch, or fuses. The switches or fuses to protect and completely disconnect the following parts:

(a) Train line (where train line is used),
(b) Battery,
(c) Axle dynamo (where axle dynamo is used).

(The axle dynamo switch or fuses to control the positive, negative and field of the dynamo.)

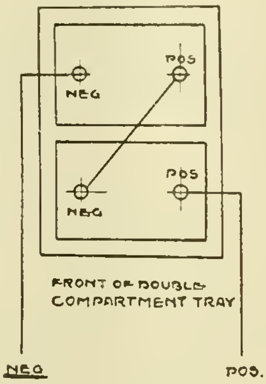


FIG. 4.

Each of the above switches or fuses to be plainly stenciled designating the part controlled.

(8) Where a main lamp switch is used, or where fuses controlling all lamps are used, they shall be so stenciled in plain letters.

(9) That all fuses on cars shall be National Electric Code fuses.

(10) That where axle dynamos are used, negative, positive and dynamo field shall be fused as close as possible to the dynamo and prior to the said leads either entering the conduits or being secured to the bottom of the car. The above fuses to be used for emergency service only and to be at least 100 per cent. above the capacity of the fuses on the switchboards protecting the same leads.

(11) That the following voltages should be used:

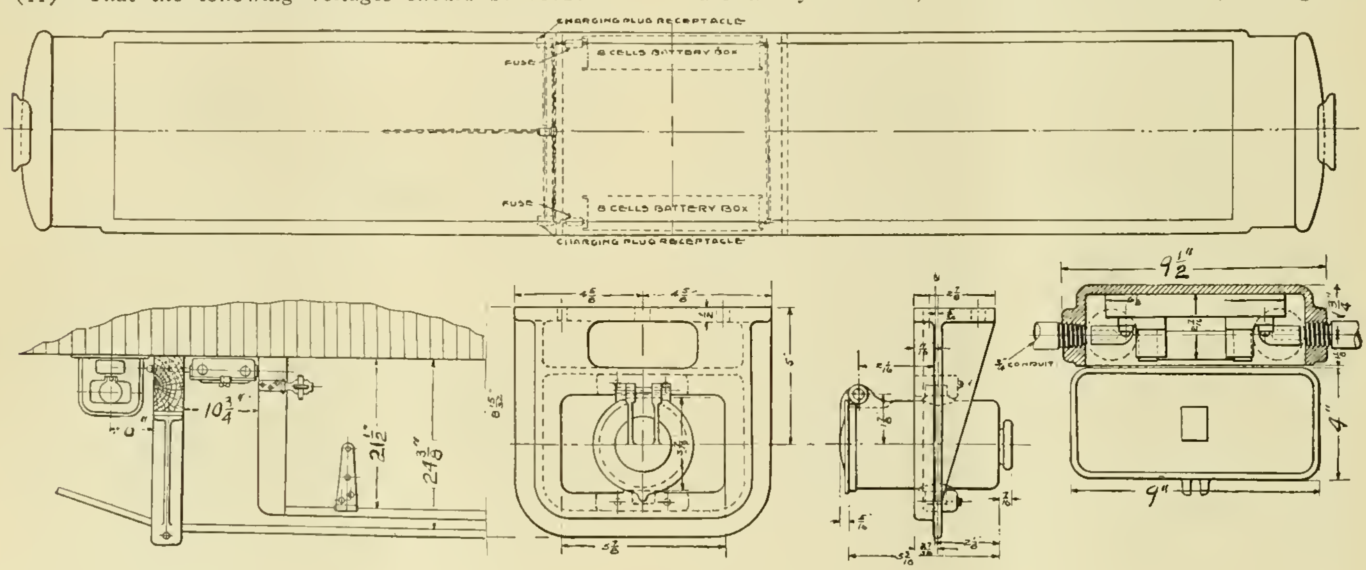


FIG. 5.

60 volts for straight storage, head end and axle dynamo systems,

30 volts for straight storage and axle dynamo systems.

(12) That batteries shall be installed in double compartment tanks as per detail dimensions and design shown. (Not reproduced.)

The committee also desires to offer the several suggestions relative to changes in the Master Car Builders' rules covering the interchange of equipment, which suggestions have been forwarded to the Arbitration Committee through the Secretary.

Discussion—The privilege of the floor was extended to Mr. Cartwright, electrical engineer of the Lehigh Valley, who criticised the report at some length, particularly where it differed from recommendations of the Association of Railway Electrical Engineers.

Mr. Wilden thought that the depreciation of 75 cents per day for batteries was too high.

Action—Report accepted and committee continued.

CAR FRAMING, ROOFS AND DOORS.

Committee:—W. F. Bentley, Chairman; J. A. McRae, R. S. Miller, C. F. Thiele, G. W. Lillie.

From investigations made in yards by the committee as a whole, as well as those made by individual members, also from recommendations and drawings submitted, we found a rapid change taking place in the detailing of each of the three subjects in question, at the same time, each subject apparently handled or detailed by the different designers from a different basis as a guide; therefore, after carefully considering, we recommend the following on each subject, and that each recommendation be considered as the minimum basis for future development.

THE CONSTRUCTION OF CAR ROOFS

That the most durable and economical roof for use is an outside metal roof of good quality of steel or wrought-iron sheets, with a minimum weight per square foot of 14 ounces, thoroughly and evenly galvanized with a minimum coating of zinc of 1½ ounces per square foot, and provided with flexible joints. Roof supported by a construction to carry at a safety factor of five, a uniformly distributed load of not less than 360 pounds per running foot of length of car.

The carlines should be metal, so constructed in connection with purlins running lengthwise, and roof boards running crosswise of car, to provide proper tie and bracing to side and end framing at roof line.

We recommend that the above details be submitted to letter ballot, with a view of adopting as minimum requirements for Recommended Practice of the M. C. B. Association.

Our reasons for the above are, that inside metal roofs are causing considerable trouble after every effort to get a strong roof construction, and after paying a very fair price for lumber entering into such a construction, nevertheless can not be held intact, on account of lumber splitting, shrinking, warping and decaying; also due to nails breaking, rusting or enlarging of nail holes, thereby failing to hold purlins or other parts, and permitting roof sheets or roofing boards to shift, lift off or slide out of place, and with certain forms of construction the entire roof has been known to lift off, thus causing leaks, and in so sliding are liable to strike and rake passing trains; further, the metal inside sheets, which are mostly concealed, crack and rust out in time, causing leaks that can only be located with difficulty and considerable expense.

The double board and inside plastic, and similarly constructed roofs, have short life, due to decay and inability to hold intact for reasons stated above.

We understand one railroad is applying, experimentally, a number of steel-riveted roofs made of plates about .1 of an inch in thickness; further, that there are on the market steel roofs and carlines, with the roof sheets removable and of heavy-gauge steel plates, which later construction of roof sheets provide flexibility.

END BRACING FOR BOX CARS

That the minimum end construction for the box car of wood superstructure and of American Railway Association dimensions be provided with oak center end posts, 5 by 5, and oak braces, 5 by 5, or material of equal strength, substantially secured at each end through the medium of very substantial pocket castings, properly lipped, to prevent shifting by strains due to ordinary shifting of any lading from within, at the same time car provided with end plate, equal to 4¼-inch Y pins in thickness, the end plate as well as belt rail, or rails, strapped or very securely tied to side plate and side belt rails respectively. The end lining to be 1¾ inches in thickness and extend from about 1 inch above lower edge of end plate to within 3 inches from floor or subsill on cars so provided.

The lining at upper edge of belt rail, or rails, to clear same by ½ inch, to permit grain getting between lining and siding to fall into car as grain is unloaded; further, that at points where braces and posts meet near the bottom, openings be provided in the lining to permit grain and other similar lading getting between lining and siding below belt rail, or rails, to fall into car as contents are unloaded.

At the floor line where lining comes to within 3 inches of floor level or subsill on cars so provided, bevel strip measuring 3 inches on the square sides must be neatly and closely fitted and secured to floor between posts and braces to prevent grain pressure acting on inside of siding and forcing it outward; this to prevent grain leakage.

The end construction, including floor, as well as floor at side and door posts, also floor at draft bolts, must be very carefully fitted to prevent grain leakage at these points.

Care should be exercised in new construction and repairs to keep inside surfaces as free from projections as possible, so as to meet the requirements of the American Railway Association Rules and the Interstate Commerce Commission Regulations for the transportation of explosives, inflammable articles and acids.

In box-car construction with metal or part metal superstructure the end construction must be at least as strong as the minimum end construction of entire wood superstructure; further, the lining, flooring, bevel strips, etc., above specified, must be carefully carried out, and interior surfaces must be smooth, to prevent damaging of lading.

We recommend that the above details be submitted to letter ballot, with a view of adopting as a minimum requirement for Recommended Practice of the M. C. B. Association.

Our reasons for the above are, that the minimum dimensions for material as specified, with secure end pockets, also tieing, etc., are not excessively strong, and break in case of severe rough handling.

We are submitting for information of those interested a drawing, Fig. 1, which shows a method of end bracing in use on some cars, and which seems to have considerable merit and might be employed to advantage when repairing old equipment where it is considered the condition would justify.

BRACING FOR SIDE DOORS.

The outside-hung, side-sliding door, per drawing (not reproduced), also flush side door, per drawing (not reproduced), are to represent the minimum requirements in the door construction and details shown. Care should be exercised in selecting proper fixture details for use as part of the complete box-car side doors.

We recommend that the above, on bracing for side doors of box cars, including drawing herewith submitted, be submitted to letter ballot, with a view of adopting as Recommended Practice of the M. C. B. Association, and to supersede the Recommended Practice as included to date on this subject.

Our reasons for the above are, that side doors of box-car equipment are generally found in poor shape in many respects, and we feel that we cannot impress upon the members of this convention too strongly or forcibly the necessity of greater care being exercised in the design of new doors and the maintenance of existing doors and parts connected therewith. Passing trains are being scraped and other accidents are occurring by doors falling off or swinging out.

In the examination of many cars loaded and empty in various yards, the committee was very forcibly impressed with the fact

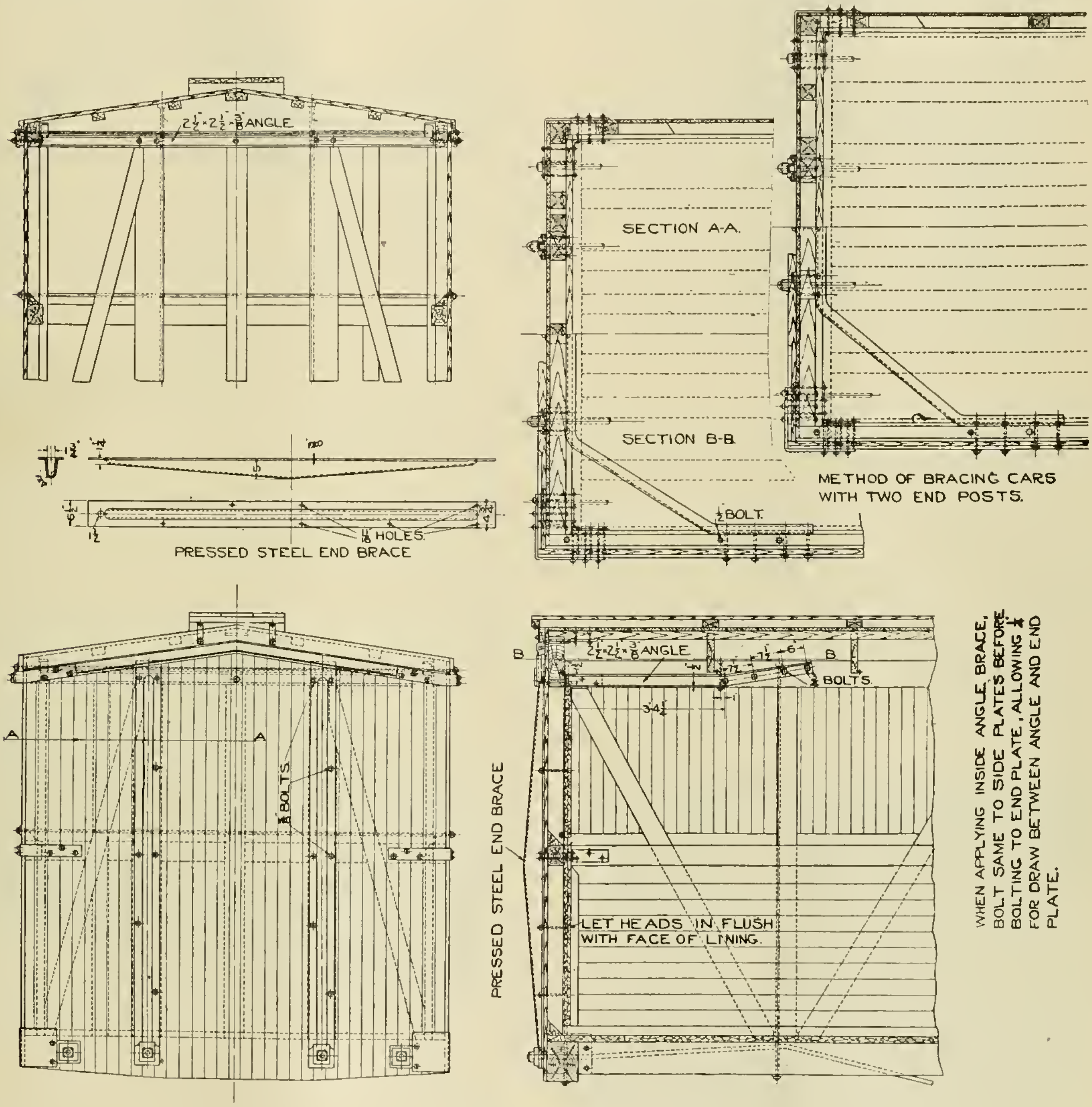


FIG. 1.—A METHOD OF END BRACING.

that door tracks, door hangers, door hasps, door-hasp keepers, door hoods and door-guide brackets are not being maintained in proper repair on existing cars, and in many cases doors were found worn or broken away at corners, to the extent that when doors were closed the door-guide brackets would not engage or hold doors at the bottom.

We further recommend that the door-hood coverings be omitted from new cars, and as much as possible in repairs to old cars, not only on account of becoming loose, but for the more important reason that they conceal and prevent proper inspection of the door tracks, door hangers and door rollers, thus preventing proper maintenance and menacing passing trains.

It will be noted on drawing for outside-hung sliding door, as submitted, that some modifications have been made since the same door was submitted for consideration at the 1909 convention, to meet criticisms made.

1. A lip has been added to the open door-stop, which is fastened to belt rail so as to better support the door from swinging out when in a full open position.

2. A note has been added to the drawing in substance as follows: "There must not be less than two bottom door-guide brackets supporting the door in any position, and not less than three bottom door-guide brackets supporting the door in the closed position." This note is added to emphasize the committee's location of bottom door-guide brackets, and we are satisfied, if closely followed, will overcome most of the trouble now experienced with outside doors swinging out.

3. A change has been made in the door handle, for the reason that men operating doors equipped with handles similar to the one on 1909 committee's drawing complained that door handles cut into gloves and hands.

4. Closed door wooden stop and stop brackets have been moved back a sufficient amount to give the door opening the full clearance provided for in the frame.

In considering the matter of flush car doors, the one that seems to be in most general use and which seems to give the most satisfaction is the Wagner car door substantially as shown in the M. C. B. 1896 Proceedings on page 286. Some changes have been made by lipping the upper door operating rod slides over the top rail and increasing the rabbet at sides of door from 7/8 to 1½ inches.

The men at freight houses who operate these doors claim they open more easily than outside-hung doors, because the first movement of car door is away from the load and car, while outside-hung sliding doors are frequently retarded in sliding by bulged sides, etc.

We know of no patents on the Wagner door and details as shown on drawing submitted.

We are also submitting, for information of those interested, prints showing general arrangements of "The Horn flush car door" (not reproduced), which several members of the committee had an opportunity to see operated on a car, but as patents are applied for on this device, prints are submitted without comment.

Discussion—Mr. Trimyer objected to the use of purlins and cross sheathing for metal roofs. His experience had indicated the use of longitudinal roof boards as preferable. He also thought 1¼ inch end lining was thick enough.

Mr. Seley also favored longitudinal roof boards, but favored the 1¾ inch end lining.

Mr. Hennessey did not favor the longitudinal roof boards. His experience was that the method recommended in the report was best.

Mr. Curtis thought that the details of some of the door fixtures and attachments should be shown more clearly.

Mr. Carr recommended the use of a Z bar for a door stop.

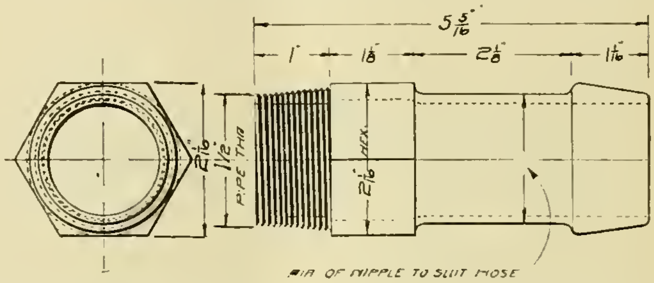
It was finally decided to refer only that part of the committee's report concerning the bracing of side doors to letter ballot. ballot.

TRAIN PIPE AND CONNECTIONS FOR STEAM HEAT.

Committee:—I. S. Downing, Chairman; H. E. Passmore, T. H. Russum, J. J. Ewing.

In considering this subject the committee decided to make tests to get a comparison between the large hose and couplings and medium hose and couplings. Tests were conducted at Collinwood on a train of thirteen cars, equipped with 2-inch pipe in the usual manner: Inlet controlling valves were all closed; steam was turned on at head end of train and time noted. When water appeared at the rear end the time was noted; when steam appeared the time was also noted. When steam appeared the valve on the rear end was closed. Time to get 10, 20, 30, 40, 50, 60 pounds in rear car was also noted.

From the data obtained, we find, of course, that the large coupling will allow steam to pass more freely than the medium, but the difference is not so great as to be of much consequence. We believe that either large or medium is entirely satisfactory. When the Master Car Builders adopted the large coupling and hose as Recommended Practice, in 1903, many prominent railroads immediately accepted the recommendation and put the large equipment on all of their passenger cars and passenger locomotives. On the other hand, there are many prominent railroads using the medium equipment, which is doing good work. Fortunately, however, the location of the roads using the large coupler is such that their passenger equipment seldom interchanges with the roads using the medium coupler; therefore, no difficulty whatever, so far as we can see, will ensue if the roads now using the large coupler continue its use, and the roads now using the



medium coupler continues its use. For this reason the committee does not recommend either for standard of the Association.

We do not recommend any end valve as standard at this time.

Recommendations.—1. Two-inch train line.

2. Location of steam train-line signal and brake pipe as shown on M. C. B. Sheet Q, with the following note: "The dimensions underscored should be maintained, but departure from other dimensions are allowable to suit conditions. Opening shown on steam line is the opening of train end valve."

3. End train-pipe valves.

4. Hose to be 31 inches from face of coupler gasket to end of nipple.

5. Nipple on coupler to be 20 degrees minimum and 25 degrees maximum angle with horizontal.

6. Nipple as shown in the illustration.

It seemed to be the consensus of opinion that a standard steam heat hose should be adopted and a motion was carried providing that the committee be continued and instructed to prepare standard dimensions and also specifications for steam heat hose.

MOUNTING PRESSURES FOR VARIOUS SIZES OF AXLES AND KINDS OF WHEELS.

Committee:—E. D. Nelson, A. Forsyth, W. T. Gorrell, J. F. Walsh, W. P. Richardson.

To specify certain mounting pressures for wheels and not specify the greater workmanship in boring the wheels and turning the wheel seats of the axles, would be only incomplete information.

A very careful study has been made in one of the larger railroad shops, covering the entire operation of machining and mounting wheels and axles, with the idea of improving the work, and, if possible, reducing the cost.

It developed that proper mounting of wheels depends on the grade of workmanship in turning the wheel seats and boring the wheels.

It has further been demonstrated that the work can be done properly without any additional cost over a lower grade of workmanship and with the same grade of men as ordinarily employed. The men employed on this class of work usually become experts and can, if properly instructed, turn out work of the best character.

It is important to consider that good work cannot be performed without good tools. Proper shop practice will not permit lathes and boring mills to get in bad repair. Lathe centers out of line or the V's worn may allow an axle to be turned tapered, while lathes in proper repair will insure wheel seats being turned straight. A tapered wheel seat with the wheel bored straight cannot be expected to make a proper fit at any mounting pressure.

A very satisfactory test for lathes is to take two or three light cuts from an axle wheel seat, say seven inches long, and measure the diameters with micrometer calipers. Good practice indicates that there should not be a variation in diameter exceeding two one-thousandths (.002") of an inch. The same attention given to lathes should be extended also to boring mills to see that they are in proper condition to turn out good work.

The general tendency has been to finish axles with too rough a wheel seat, which results from too coarse a feed. This makes only partial contact between the wheel seat and axle. While axles may hold satisfactorily under these conditions, there is always an element of uncertainty, which can be eliminated by better practice. The axle, roughly turned in this way, cannot be accurately calipered, and this is the essential to good fitting and security. Furthermore, in mounting the wheel, the high ridges obtained with a roughly turned wheel seat are pushed off, principally at the outer end of the axle, reducing its diameter and making the turning of the wheel seat necessary when preparing the axle for mounting wheels at a later time. There is, also, a bad moral effect on men, who, if permitted to carry out this practice, will extend it to journals as well.

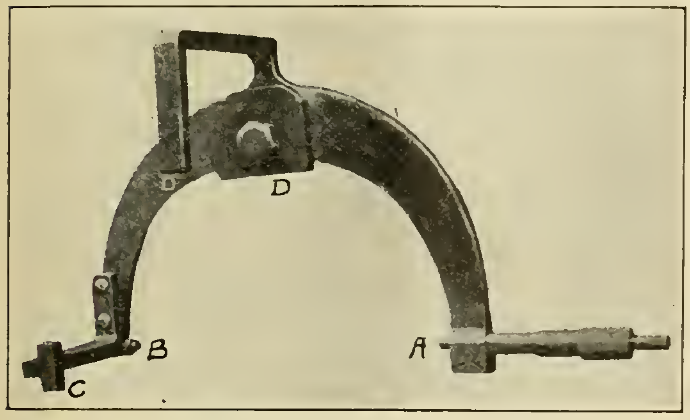


FIG. 1.

It has been demonstrated that with fairly rigid lathes axles can be turned at a speed of forty to fifty revolutions per minute, the limit of speed being the chattering of the tool rather than the cutting speed. With this high speed run with a fine feed, an axle can be turned in about the same time as by slow speeds and coarser feed. The higher speed results in better work without increased cost.

Having secured straight and true wheel seats and wheel bores, the next necessity is for the proper diameters necessary in secure mounting.

Micrometer calipers are necessary for several reasons. The axles and wheels can be calipered more quickly and more accurately than by machinist's calipers or snap gauges. The "draw" or difference in diameter of wheel seat and bore which has been determined for a proper fit, can be secured without difficulty. The difference between diameters of wheel seat and bore of wheel expressed in thousandths of an inch, can be measured accurately, whereas with ordinary calipers it is a question of skill of the workman and with snap gauges the same is true to a lesser degree.

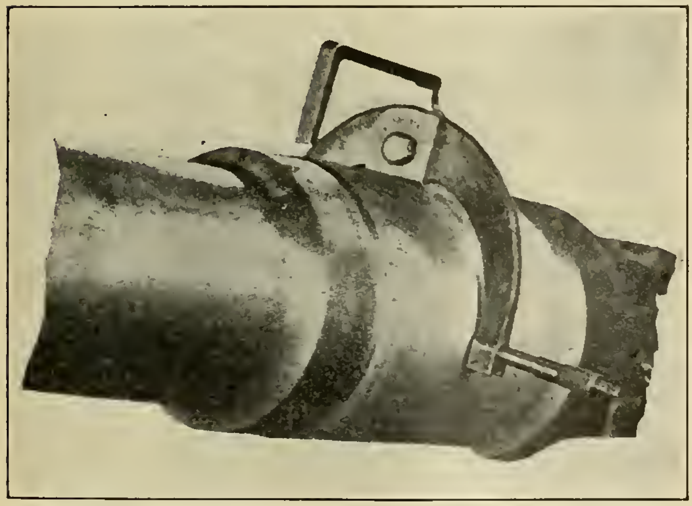


FIG. 2.

For shop inspection, certain limits can be set between which the axle or wheel may vary and be good enough for all requirements. The inspector having set limits is not permitted to use judgment, which is always liable to error; if the work is within the limits he must pass it.

If not, it must go back to the man who did the work, and he, knowing his work must meet certain definite requirements determined by the proper measuring instrument, naturally endeavors to turn out good work rather than take the chance of doing it over without pay.

To successfully use, for wheels and axles, the ordinary trade micrometer caliper, takes time and a certain amount of skill. To reduce his time and skill to the minimum, micrometer calipers have been designed and used successfully. Fig. 1 shows a photograph of caliper for wheel seats. "A" is an ordinary micrometer head that can be bought in the open market; "B" is the anvil; "C" is a stop set square with a line through "A" and "B"; "D" is a stop or limit which may be turned, so that the distance from the stop to the line from "A" to "B" shall be approximately the radius of the wheel seat. In practice, this stop "D" for the 5½ in. by 10 in. journal axles is correct for wheel seats 6⅞ in. in diameter, and is approximately correct for wheel seats from 6¾ in. to 7 in. By turning the stop "D" one-quarter turn, it is suitable for 5 x 9 in. journals.

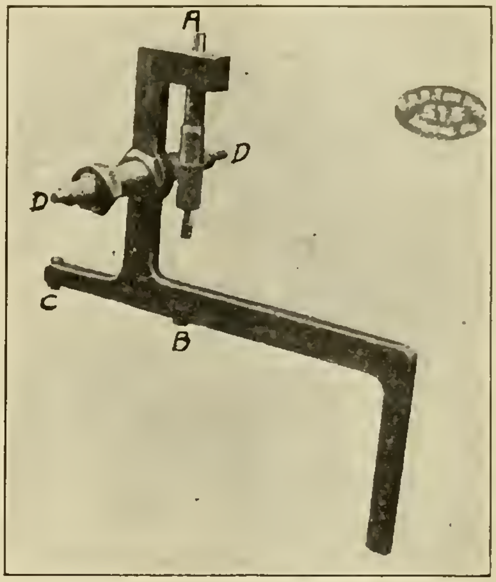


FIG. 3.

In using this caliper it is placed over the axle, with stop "D" resting on the wheel seat, as shown in Fig. 2. The stop "C" and anvil "B" are then brought firm against the wheel seat. The micrometer is screwed up by a ratchet stop until the ratchet clicks. The caliper is then removed and read. On a trial, eight axles were measured in five minutes and twelve wheels were measured in the same space of time. Each wheel seat was measured at three points, the average taken and size chalked on the axle. The wheel seats had not been previously measured and but few were of the same size. This is much more rapid than calipering by other means, especially for axles varying in diameter.

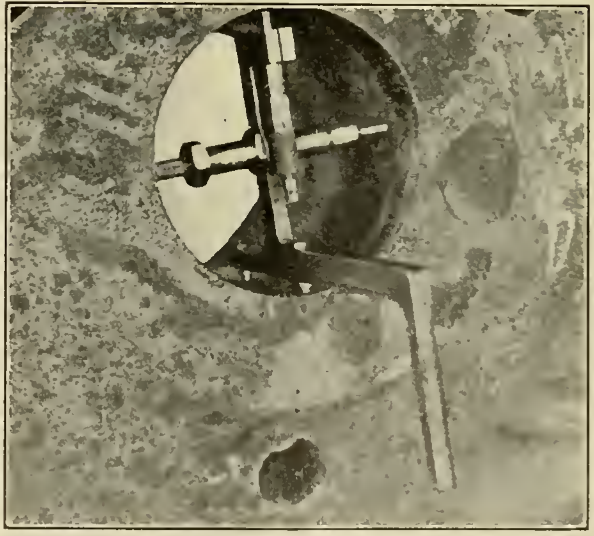


FIG. 4.

Fig. 3 illustrates a caliper for wheel bore. "A" is the micrometer head, but graduated for internal measurement; "B" is the anvil; "C" the stop, set at right angles to a line from "A" to "B"; "DD" are right and left hand screws, turning together by means of a link not shown.

In calipering a wheel the screws "DD" are roughtly adjusted somewhat smaller than the bore of the wheel. The anvil "B" and stop "C" are brought against the bore and micrometer screwed out until the ratchet clicks. (See Fig. 4.) On a trial five wheels were calipered and size chalked on wheel in five minutes.

The measuring was done by an apprentice, who was able to do it in an entirely satisfactory manner after about one hour's instruction.

This method of calipering and marking each wheel seat with the points and the further calipering of the bored wheels with the sizes marked upon them, permits the proper selection of wheels at wheel seats for mounting, in order to secure the pressures necessary.

As to mounting pressures, the committee recommends the following, in conjunction with the character of workmanship already referred to, as being an essential in the problem:

WHEELS

M. C. B. Axle	Size of Journal	Cast Iron (Tons) Maximum	Cast Iron (Tons) Minimum	Steel (Tons) Maximum	Steel (Tons) Minimum
A	3¾ in. x 7 in.	44	36	66	54
B	4¼ in. x 8 in.	44	36	66	54
C	5 in x 9 in.	55	45	83	68
D	5½ in. x 10 in.	55	45	83	68

The following general specifications, which have been quite thoroughly tested, are submitted for consideration.

AXLE WHEEL FIT.

Must be turned as smooth as possible with lathe tool having flat cutting edge. Finishing cut must not be taken with lathe feed coarser than 16 pitch. Taper on axle wheel seat for entering wheel must not exceed one-half inch in length and must be turned with broad, straight faced tool, making regular taper without ridges or rings. Wheel fits to be calipered at three points, namely:

One inch from each end and middle and other points of indications point to excessive variations in diameter.

Axles should be considered as suitable for mounting where there is a difference in diameter between any two measurements exceeding .003 of an inch. This, however, should not be construed to mean that wheel seats on each end of axle are to be of one size. Each tenth axle from each lathe shall be measured for soundness. No axle varying over .001 of an inch when measured at two points ninety degrees apart on circumference at equal distance from end shall be considered as suitable for mounting.

WHEELS.

To be bored smooth. Finishing cut shall be made with tool or tools having a cutting face at least 3-16 of an inch wide. Feed not to exceed 8 pitch. To be bored with a rough and finishing cut. The finishing cutter when taking the finishing cut must not be cutting when roughing tool is also rough-boring, unless the finishing tool is supported independent of roughing tool, the latter to prevent spring of roughing tool being transmitted to finish tool, causing an irregular bore.

Wheels to be calipered with micrometer caliper. A wheel varying over .002 of an inch in any two diameters will not be considered satisfactory for mounting.

Mounting presses to be provided with recording pressure gauges. All wheels not mounted within limits given, or wheels that are forced against shoulder, to be withdrawn.

One point that may be foreign to the subject should receive attention, which is lathe centers. It would be very desirable if all shops were to adopt one angle. Generally, lathe centers used for ordinary work are sixty degrees, including angle. If this were adopted for all axle work, it would result in the axles running true on centers, reducing the amount of material necessary to turn away when truing up axles that have been previously turned.

Discussion—Mr. Vaughan criticised the report in that it only specified maximum and minimum mounting pressures. He felt that any specification for mounting wheels should include the pressure when the wheel is partly pressed on.

Mr. Curtis believed the report should specify that the ton mentioned was a net ton.

Action—The report was accepted and ordered to be printed in the proceedings.

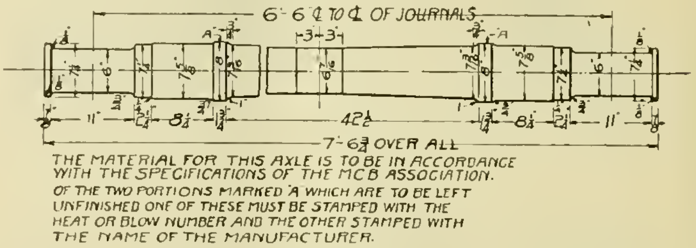
DESIGN OF FREIGHT-CAR AXLE TO CARRY A LOAD OF 50,000 POUNDS.

By E. D. Nelson.

During the past year it has come to my attention that there are at least four railroad companies, represented in the Master Car Builders' Association, which have had under consideration a car axle of a larger capacity than the Standard "D" axle of this Association. As a matter of fact, there have been designs made of axles of larger capacity, and naturally these differ somewhat in detail.

The importance of eliminating variations in design is apparent, and I have, therefore, considered it advisable to present a design of axle having a capacity of 50,000 pounds, with a view to its consideration at the present convention.

If the Association would, after consideration, recommend that the adoption of this design as Recommended Practice for one year be submitted to letter ballot, it would give an opportunity to establish a design which could be followed by any



PROPOSED "E" AXLE, M. C. B.

railroad company during the coming year and prevent axles of larger capacity than the "D" axle and, varying in detail, getting into service.

In submitting this design of axle of 50,000 pounds capacity, the method outlined in the report of the Committee on Axle, Journal Box, Bearing and Wedge, made to the convention of 1896, has been followed. The method outlined at that time is applicable to axles of any capacity, so far as our present knowledge is concerned. The assumed data are as follows:

Weight of body and trucks	55,580 lbs.	
Weight of lading	140,000 "	
10 per cent. additional lading	14,000 "	
Total		209,580 lbs.
Deduct weight of 8 33-inch forged steel wheels	5,720 "	
Deduct weight of 4 axles	3,860 "	
Total		9,580 "
Total weight on four axles		200,000 "
Total weight on one axle		50,000 "

Assuming for this load that the journal should be 11 inches long, its diameter should be, according to (Formula 5), page 152, and by substitution in (Formula 12), page 153, M. C. B. Proceedings of 1896, 5.38 inches. Taking the nearest ⅛ of an inch above this makes the diameter 5½ inches, and an allowance of ½-inch diameter for wear brings the diameter of the journal, when new, to 6 inches.

Assuming then, that the journal is 6 inches in diameter by 11 inches long, the consideration so far as friction and lubrication are concerned, would be, quoting the figures from page 169 of the Proceedings of the Association of 1896, as follows:

4¼ by 8 inch journal, new, pressure per square inch..449 pounds
5 by 9 inch journal, new, pressure per square inch..469 pounds
5½ by 10 inch journal, new, pressure per square inch..470 pounds
6 by 11 inch journal, new, pressure per square inch..503 pounds
4¼ by 8 inch journal, old, pressure per square inch...533 pounds
5 by 9 inch journal, old, pressure per square inch...525 pounds
5½ by 10 inch journal, old, pressure per square inch...516 pounds
6 by 11 inch journal, old, pressure per square inch...549 pounds

These figures indicate that from the standpoint of friction and lubrication, satisfactory service may be expected from these journals.

Concerning the diameters of the axle at the wheel seat and center (Formula 10), page 152, and (Formula 12), page 153, of the Proceedings of 1896, give the following diameters:

Wheel seat ....7.40 inches
Center ....6.30 inches

For the wheel seat it has been customary to add ¼ of an inch to the calculated diameter, which would make the diameter at the wheel seat, when new, 7.650 inches. It has been customary, however, to keep the diameters at the wheel seat to the nearest ⅛ of an inch, and by making the diameter 7⅝ inches, ¼ of an inch diameter can be secured above the calculated diameter within 2½ one-hundredths of an inch, to the calculated diameter at the center, and an allowance must be made for the cylindrical portion of the axle, so that this portion does not change abruptly at its intersection with the taper portions of the axle. Taking the diameter to the nearest 1-16 of an inch, would make the diameter at the center 6 7-16 inches. The principal dimensions, with the axle new, will, therefore, be as follows:

Journal, diameter	6 inches
Journal, length	11 inches
Wheel seat, diameter	7⅝ inches
Center, diameter	6 7-16 inches

The satisfactory results which have been obtained with former designs of axles of the M. C. B. Association, based on the formula as given in the report of 1896, seem to warrant the use of a fibre stress of 22,000 pounds per square inch as used for all of the previous M. C. B. axles, and this figure has been taken in the formulas in order to arrive at the diameters which have been given.

The attached drawing shows all the dimensions of the proposed axle. It has been designated in accordance with the former practice of the Association as Axle "E" and the quality of the material is to be the same as that required by the present M. C. B. Specifications.

Attention should be called to the fact that in the design of axle submitted, the distance between the dust-guard seats is 62½ inches, while in all of the other designs of axles of the Association it is 63 inches. In the design submitted, this ½ inch was taken off in order to get more clearance back of the journal box, and this will necessitate ¼ of an inch more dish in the wheels mounted on this design. While at first thought this may apparently indicate inability to interchange wheels between axles, it should be stated that the forged wheels with outside hub diameters suitable for the No. "D" axle, can probably not be bored out so as to fit the present design of axle and leave sufficient material in the hub. It will, therefore, mean that for the axle herewith submitted a special design of wheel will be required.

It is only necessary to add finally that, while the axle herewith submitted is nominally for a car having a capacity of 140,000 pounds, it must be understood that the axle is designed to carry a given load and the capacity of the car is only incidental. If a car body weighing less than that assumed above can be constructed, the decrease in the light weight can, of course, be added to the capacity. The point which should be emphasized is that the axle is designed to carry a load of 50,000 pounds and is not necessarily an axle suitable for a car of 140,000 pounds capacity, regardless of the weight of the car body on the trucks.

Discussion—It was explained by Mr. Kiesel that a special wheel would have to be designed to go with this axle anyway and that it would be possible to use the same wheel for 100,000 lb. capacity cars.

Mr. C. D. Young drew attention to the fact that this axle was but the start of a whole new truck.

Action—Referred to letter ballot for recommended practice.

LUMBER SPECIFICATIONS.

Committee:—American Ry. M. M. Assn.: R. E. Smith, J. F. DeVoy.

Committee:—Master Car Builders' Assn.: G. N. Dow, Chairman; G. H. Gilman, R. W. Burnett.

This matter has been thoroughly canvassed by committees of the Master Car Builders' Association, American Railway Master Mechanics' Association, the Railway Storekeepers' Association and the various lumber manufacturers' associations throughout the country. The specifications meet the approval of the various committees, and especially of the lumber manufacturers.

In order to have standard descriptions of the various woods used by railroads, the following standard names for car and locomotive lumber were agreed upon by the Joint Committee:

1. *Ash.*—To cover what is known as White Ash, Black Ash, Blue Ash, Green Ash and Red Ash.
2. *Basswood.*—To cover what is known as Linden, Linn, Lind or Lime-tree.
3. *Beech.*—To include Red or White Beech.
4. *Birch.*—To include Red, White, Yellow and Black Birch.
5. *Buckeye.*—To cover what is known as Horse Chestnut.
6. *Butternut.*—To cover wood from tree of that name, also known as White Walnut.
7. *Cherry.*—To include Sweet Cherry, Sour Cherry, Red Cherry, Black Cherry and Wild Cherry.
8. *Chestnut.*—To cover wood from tree of that name.
9. *Cottonwood.*—To cover wood from tree of that name. (Do not confuse with Popple or Poplar.)
10. *Cypress.*—To include Red Cypress, Gulf Cypress, Yellow and East Coast Cypress, also known as Bald Cypress.
11. *Elm—soft.*—To cover what is known as White Elm, Gray, Red and Winged Elm.
12. *Elm—rock.*—To cover what is known as Rock Elm.
13. *Douglas Fir.*—To cover Yellow Fir, Red Fir, Western Fir, Washington Fir, Oregon or Puget Sound Fir or Pine, Northwest and West Coast Fir.
14. *Gum.*—To cover what is known as Red Gum, Sweet Gum or Satin Walnut.
15. *Hemlock.*—To cover Southern or Eastern Hemlock; that is, Hemlock from all States east of and including Minnesota.
16. *Western Hemlock.*—To cover Hemlock from the Pacific Coast.
17. *Hickory.*—To include Shellbark, Kingnut, Mockernut, Pignut, Black, Shagbark and Bitternut.
18. *Western Larch.*—To cover species of Larch or Tamarack from the Rocky Mountain and Pacific Coast regions.
19. *Maple—soft.*—To include Soft and White Maple.
20. *Maple—hard.*—To cover what is known as Hard, Red, Rock and Sugar Maple.
21. *White Oak.*—To include White Oak, Burr Oak or Mossy Cup, Rock Oak, Post or Iron Oak, Overcup, Swamp Post, Live Oak, Chestnut Oak or Tan Bark, Yellow or Chinquapin Oak, Basket or Cow Oak.
22. *Red Oak.*—To include Red Oak, Pin Oak, Black Oak, Water Oak, Willow Oak, Spanish Oak, Scarlet Oak, Turkey Oak, Black Jack or Barn Oak, and Shingle or Laurel Oak.
23. *Pecan.*—To cover wood from tree of that name.
24. *Southern Yellow Pine.*—Under this heading two classes of timber are used: (a) Long-leaf Pine; (b) Short-leaf Pine. It is understood that these two terms are descriptive of quality rather than of botanical species; thus, Short-leaf Pine would cover such species as are known as North Carolina Pine, Loblolly Pine and Short-leaf Pine. Long-leaf Pine is descriptive of quality, and if Cuban, Short-leaf or Loblolly Pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true Long-leaf, it would be covered by the term Long-leaf Pine.
25. *White Pine.*—To cover timber which has hitherto been known as White Pine, from Maine, Michigan, Canada, Wisconsin and Minnesota.
26. *Norway Pine.*—Also known as Red Pine, from Michigan, Minnesota, Wisconsin and Canada.
27. *Idaho White Pine.*—To cover variety of White Pine from western Montana, northern Idaho and eastern Washington.
28. *Western Pine.*—To cover timber known as White Pine coming from Arizona, California, New Mexico, Colorado, Oregon and Washington. This is the timber sometimes known as Western Yellow or Ponderosa Pine or California White Pine or Western White Pine.
29. *Poplar.*—To cover wood from the Tulip Tree, Whitewood, Yellow Poplar and Canary Wood.
30. *Redwood.*—To include the California wood usually known by that name.
31. *Spruce.*—To cover Eastern Spruce; that is, the Spruce timber coming from points east of and including Minnesota and Canada, including White, Red and Black Spruce.
32. *Western Spruce.*—To cover the Spruce timber from the Pacific Coast.
33. *Sycamore.*—To cover wood from tree of that name, otherwise known as Buttonwood.
34. *Tamarack.*—To cover timber known as Tamarack or Eastern Tamarack, from States east of and including Minnesota.
35. *Tupelo.*—Otherwise known as Tupelo Gum, Bay Poplar.
36. *Walnut.*—To cover Black Walnut (for White Walnut, see Butternut).

It is the opinion that the specifications which we have proposed cover nearly 95 per cent. of the lumber used in car and locomotive construction and maintenance, and the question of drawing specifications for the special hardwoods, such as mahogany and other imported lumber, was left open for further consideration.

RECOMMENDED CLASSIFICATION, GRADING AND DRESSING RULES FOR NORTHERN PINE CAR MATERIAL, INCLUDING WHITE AND NORWAY PINE AND EASTERN SPRUCE

[*The committee here give detailed definitions of the various defects, including knots of all kinds, pitch, wane and sap, which, because of their length, are omitted.*—ED.]

MISCELLANEOUS

Defects in rough stock caused by improper manufacture and drying will reduce grade unless they can be removed in dressing such stock to standard sizes.

All lumber for uses described in these rules shall be inspected on the face side to determine the grade, and the face side is the side showing the best quality or appearance.

Chipped grain consists in a part of the surface being chipped or broken out in small particles below the line of the cut, and as usually found should not be classed as torn grain, and shall not be considered a defect.

Torn grain consists in a part of the wood being torn out in the dressing. It occurs around knots and curly places, and is of four distinct characters; slight, medium, heavy and deep.

Slight torn grain shall not exceed 1-32 of an inch in depth, medium 1-16 of an inch, and heavy ⅛ of an inch. Any torn grain heavier than ⅛ of an inch shall be termed deep.

The grade of all regular stock shall be determined by the number, character and position of the defects visible in any piece. The enumerated defects herein described admissible in any grade are intended to be descriptive of the coarsest pieces *such grades may contain,* but the average quality of the grade shall be midway between the highest and lowest pieces allowed in the grade.

Lumber and timber sawed for specific purposes must be inspected with a view to its adaptability for the use intended.

All dressed stock shall be measured strip count, viz.: full size of rough material necessarily used in its manufacture.

Lumber must be accepted on grade in the form in which it was shipped. Any subsequent change in manufacture or mill work will prohibit an inspection for the adjustment of claims, except with the consent of all parties interested.

The foregoing general observation shall apply to and govern the application of the following rules:

B and Better White Pine.—Material of this grade should be practically clear and free of all defects, except not exceeding three or four pin knots, and bright sap not to exceed 25 per cent. of the face of the piece.

C and Better Norway Pine.—Bright sap is no defect in this grade and stained sap will be admitted to the extent of not exceeding 1-5 the surface of the face of the piece, if not in combination with other defects. This grade should be free from shake, rot, splits, but will admit of three or four pin knots.

No. 1 Common White Pine, Norway Pine and Eastern Spruce.—This grade admits of small sound knots, but should be free from large or coarse knots, knotholes, should have practically no shake, wane or rot, but will admit of bright sap to any extent.

No. 2 Common White Pine, Norway Pine and Eastern Spruce.—This grade is similar to No. 1, described above, except that it will admit of spike knots, bright or stained sap, slight shake, slight wane on reverse side, but not a serious combination of any of these defects.

No. 3 Common White Pine, Norway Pine and Eastern Spruce.—This grade, in addition to the defects mentioned in No. 2 described above, will also admit of large or coarse knots, more shake, sap, wane on reverse side that does not affect the tongue or groove and torn or loosened grain, checks, pin wormholes or splits, but no loose knots or knotholes, nor a serious combination of the defects named.

No. 1 Common Norway Pine Car Decking or Flooring.—This grade will admit of sound knots, any amount of sap, and shall be free from shake, wane, rot or large, coarse spike knots.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Roofing: 5 feet or multiples. Car Lining: 8, 9, 10, 12, 14, 16, 18 and 20 feet or multiples. Car Decking: 9 and 10 feet or multiples.

All orders shall be shipped in the standard length called for, unless otherwise specified, but no lengths of either car siding, lining or roofing shall be shipped except in the lengths specified or multiples thereof. Those who do not desire stock shipped in multiple lengths should so specify.

RECOMMENDED CLASSIFICATION GRADING AND DRESSING RULES FOR SOUTHERN YELLOW PINE CAR MATERIAL

[*Similar definitions of the defects mentioned under pine are omitted.*—ED.]

The foregoing general observation shall apply to and govern the application of the following rules:

B and Better Car Siding, Lining and Roofing will admit any two of the following, or their equivalent of combined defects: Sap stain not to exceed five per cent.; firm, red heart not to exceed fifteen per cent. of the face; three pin knots; one standard knot; three small pitch pockets; one standard pitch pocket; one standard pitch streak; slight torn grain, or small kiln or season checks. Where no other defects are contained, six small pin wormholes will be admitted.

Select Car Siding will admit of one standard pitch streak, one standard pitch pocket, or their equivalent; and, in addition, will admit of not exceeding fine pin knots and two standard knots, or their equivalent; ten per cent. sap stain; firm red heart; slight shake; heavy torn grain; defects in manufacture or seasoning checks. Pieces otherwise good enough for B, but containing a limited number of pin wormholes shall be graded *select.* This grade is intended to be accumulated from running B and Better stock, and will consist of all the droppings which do not contain defects in excess of those mentioned in this paragraph.

No. 1 Common Car Siding will admit of the following defects or their equivalent: Sound knots, not over one-half of cross section of the piece at any point throughout its width. Three pin knots or their equivalent. Wane ½ inch deep on edge not exceeding 1½ inches wide and one-half the length of the piece. Torn grain; pitch pockets; pitch; sap stain; seasoning checks; slight shakes; firm red heart and a limited number of small wormholes well scattered.

This grade is intended to be worked from fencing stock, either kiln or air dried.

Select Car Lining and Roofing will admit of one standard pitch streak; one standard pitch pocket, or their equivalent, and, in addition, sound knots not over one-half the width of the piece in the rough; ten per cent. sap stain; firm red heart; slight shakes; heavy torn grain; defects in manufacture, or seasoning checks. Pieces otherwise good enough for B, but containing a limited number of pin wormholes shall be graded *select.* This grade is intended to be accumulated from running B and Better stock, and will consist of all the droppings which do not contain defects in excess of those mentioned in this paragraph.

No. 1 Common Car Lining and Roofing will admit of the following defects or their equivalent: Sound knots not over one-half the cross section of the piece at any point throughout its length; three pin knots or their equivalent; torn grain; pitch pockets; sap stains; seasoning checks; firm red heart, and a limited number of pin or small wormholes well scattered. This grade is intended to be worked from fencing stock, either kiln or air dried.

Standard Patterns.—(Insert B/P reference, showing net sizes after working.)

All-heart Car Decking or Flooring will admit sound knots not over one-third of the cross section of the piece at any point throughout its length, provided they are not in groups; pitch pockets; firm red heart; shake and seasoning checks which do not go through the piece; loose or heavy torn grain, or other machine defects, which will lay without waste or will not cause a leakage in cars when loaded with grain. Must be strictly *all heart* on both sides and both edges.

Heart Face Car Decking or Flooring will admit of sound knots not over one-third the cross section of the piece at any point throughout its length, provided they are not in groups; pitch pockets; firm red heart; shake and seasoning checks which do not go through the piece; loosened or heavy torn grain, or other machine defects, which will lay without waste, or will not cause a leakage in cars when loaded with grain. Will admit of any amount of sap provided all of the face side of the piece is strictly all heart.

No. 1 Common Car Decking or Flooring will admit of sound knots not over one-half the cross section of the piece at any point throughout its length, provided they are not in groups; pitch pockets; sap stain; firm red heart; shake and seasoning checks which do not go through the piece; a limited number of pin wormholes; loosened or heavy torn grain, or other machine defects, which lay without waste, or will not cause a leakage in cars when loaded with grain.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Lining: 8, 9, 10, 12, 14, 16, 18 and 20 feet or multiples. Car Roofing: 5 feet or multiples. Car Decking or Flooring: 9 and 10 feet or multiples.

All orders shall be shipped in the standard lengths called for, unless otherwise specified, but no lengths of either car siding, lining or roofing shall be shipped, except in the lengths specified or multiples thereof. Those who do not desire stock shipped in multiple lengths should so specify.

CAR SILLS AND FRAMING

No. 1 Common Heart Car Sills and Framing will admit of sound knots, provided they are not in groups, the mean or average diameter of which shall not exceed two (2) inches; pitch; pitch pockets; slight shake; seasoning checks, or other defects which will not impair its strength more than the defects aforementioned. Must be sawed from sound timber, free from doty or rotten red heart and true to measurements, or at least the measurements at no point on the sill shall be less than the size required.

Measurement of the girth at any point throughout the length of the piece must show at least 75 per cent. heartwood.

Cubical contents shall not be used as basis for obtaining percentage of heartwood under this rule.

No. 1 Common Car Sills and Framing will admit of sound knots, provided they are not in groups, the mean or average diameter of which shall not exceed two (2) inches; pitch; pitch pockets; slight shake; seasoning checks; sap; sap stain, or other defects which will not impair its strength more than the defects aforementioned. Must be sawed true to measurements and from sound timber free from doty or rotten red heart; must be square cornered, except that one (1) inch of wane on one corner or one-half (½) inch of wane on two corners is admissible.

Sizes up to 6 inches in width shall measure full when green, and not more than ⅛ inch scant when dry or part dry. Sizes 6 to 12 inches in width shall measure full when green and not more than ¼ inch scant when dry or part dry. Sizes 12 to 16 inches in width shall measure full when green and not more than ⅜ inch scant when dry or part dry. Unless otherwise specified, one-fourth inch shall be allowed for each side which is to be dressed. Where stock is wanted dressed smooth all four sides, timber shall be sawed ½ inch full over the dressed sizes required. In pieces 3 by 6 inches and under when ordered in lengths exceeding 30 feet, sound knots shall not exceed one-quarter the width of the face through which they project, and the grain shall not cross sufficient to impair the strength.

RECOMMENDED CLASSIFICATION AND GRADING RULES FOR LOCOMOTIVES, FREIGHT AND PASSENGER CAR OAK

[*Definition of various defects omitted.*—Ed.]

Locomotive Timber Oak. Passenger Car Dimension Oak. Refrigerator Car Dimension Oak.—Thickness cut to order, widths cut to order, lengths cut to order. Unless otherwise noted, must be cut from white oak. This stock, wherever practical, should be cut outside the heart and must be free of heart shake in pieces under 6 by 6 square. No attempt should be made to box the heart in pieces smaller than 5 by 7, unless heart is very small and tight. When heart is well boxed it must be firm and tight, and the center of the heart must not be nearer than 2 inches from any face. Must be sawed full to sizes with square edges, and cut from sound timber and free from wormholes, with the exception of a few small pin wormholes well scattered, and an occasional spot worm. None of these defects, however, to affect the serviceability of the piece for the purpose intended. Must be free from split, rot or dote, large, loose, rotten or unsound knots, or, in other words, free of all defects affecting the strength and durability of the piece. Sound standard knots well scatttered not considered a defect.

Freight Car Timbers.—Freight car dimension, including all cars other than refrigerator and passenger car. Sizes cut to order. Unless otherwise ordered, must be sawed from good merchantable white or red oak timber. This stock must be free of rot, shakes and splits, large, loose, rotten or unsound knots, any of which will materially impair the strength and durability of the piece for the purpose intended. This stock is intended to work full size and length without waste for side posts, braces and end sills, end plates, drafting timbers, cross ties, etc., used in the construction of ordinary freight or stock cars. On pieces 3 by 4 inches or equivalent girth measure and larger (nothing under 2 inches thick), heart check showing on one corner, admitted on twenty per cent. of the pieces in each car shipment. Well-boxed, sound hearts admitted in this material in pieces 5 by 6 and larger.

On pieces 3 by 4 to 6 by 6, inclusive, or equivalent girth measure and larger (nothing under 2 inches thick), in absence of heart defects, wane on one corner, ¾ inch side measurement, admitted on not to exceed twenty per cent. of the number of pieces in each car shipment.

Pieces over 6 by 6 square may contain 1 inch wane, side measurement, on one corner, with other conditions same as 3 by 4 to 6 by 6 sizes.

RECOMMENDED CLASSIFICATION AND GRADING RULES FOR DOUGLAS FIR CAR AND LOCOMOTIVE MATERIAL.

[*Definition of various defects omitted.*—Ed.]

The term "Edge Grain" is here used as synonymous with vertical grain, rift-sawn, or quarter-sawed. The term "Flat Grain" is synonymous with slash grain or plain sawed.

No. 2 Clear and Better Edge Grain.—Material of this grade shall be well manufactured with angle of grain not less than forty-five degrees. This stock shall be kiln-dried and practically free from all defects, but will admit of bright sap on the face; not exceeding three small close pitch pockets not over 2 inches long, one pin knot, slight roughness in dressing, but not a serious combination of these defects.

No 2 Clear and Better Flat Grain.—Material of this grade shall be well manufactured. The stock shall be kiln-dried and practically free from all defects, but will admit of bright sap on the face; not exceeding three small close pitch pockets not over 2 inches long, one pin knot, slight roughness in dressing, but not a serious combination of these defects.

No. 3 Clear.—Material of this grade should be sound common lumber and will admit of roughness in dressing, bright sap, and also may contain five pin, three small and one standard knot and five pitch pockets in any continuous 5 feet of length of the piece; or any combination of tight knots or pitch pockets equivalent to those mentioned above. This grade particularly refers to stock used for inside lining of freight cars.

Standard Car Decking or Flooring.—Stock in this grade shall be well manufactured from sound live timber and shall be free from splits, shakes, rot, bark or waney edges, and unsound knots, or pitch pockets, pitch seams or large knots which would weaken the piece for the use intended. This grade will admit of sound knots not to exceed one-third width of the piece, provided they are not in clusters, and sap.

Common Car Sills and Framing.—Stock in this grade shall be well manufactured from sound live timber, sawed full size to sizes ordered and free from rot, unsound knots, cross grain, bark or waney edges or shakes, but will admit of sap and any number of sound knots, provided they are not in clusters, and do not exceed one-third width of piece; pitch pockets or pitch seams that would not weaken the piece for the purpose intended.

Sizes up to 6 inches in width shall measure full when green, and not more than ⅛ inch scant when dry or part dry. Sizes 6 to 12 inches in width shall measure full when green and not more than ¼ inch scant when dry or part dry. Sizes 12 to 16 inches in width shall measure full when green and not more than ⅜ inch scant when dry or part dry. Unless otherwise specified, ¼ inch shall be allowed for each side which is to be dressed. Where stock is wanted dressed smooth all four sides, timber shall be sawed ½ inch full over the dressed sizes required. In pieces 3 by 6 inches and under when ordered in lengths exceeding 30 feet, sound knots shall not exceed one-quarter the width of the face through which they project, and the grain shall not cross sufficient to impair the strength.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Roofing: 5 feet or multiples. Car Lining: 8, 9, 10, 12, 14, 16, 18 and 20 feet or multiples. Car Decking: 9 and 10 feet or multiples.

GRADING RULE FOR CYPRESS CAR ROOFING, SIDING OR LINING.

Material of this grade shall be well manufactured, and kiln-dried, and will admit of sound knots, any amount of stained sap; very small pin wormholes, such as will readily fill and cover by the usual painting; slight shake; a small split; ordinary season checks; but will not admit of grub wormholes, wane, knotholes, or defects which would prevent the use of each piece in its full width and length for the purpose intended as named above.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Roofing: 5 feet or multiples. Car Lining: 8, 9, 14, 16, 18 and 20 feet or multiples.

Discussion—Mr. McCarthy, member of the committee on the same subject, from the Railway Storekeepers' Association, presented a number of slight changes that had been made since the report was printed.

Action—Referred in its corrected form to letter ballot for recommended practice. Committee continued.

SPRINGS FOR FREIGHT CAR TRUCKS.

The committee asked for more time in which to prepare a report. This was granted.

CAR WHEELS.

Committee:—Wm. Garstang, Chairman, A. E. Manchester, O. C. Cromwell, W. C. A. Henry, R. W. Burnett, A. Kearney, R. L. Ettenger.

At the last convention revised drawings for the flange and tread contour of all wheels and a revised design for the 625-pound wheel with corrected specifications covering the three wheels were presented.

The committee has held several meetings during the year, two of them being joint meetings with the car-wheel manufacturers, and from the reports of the manufacturers and what we have heard from other lines, the indications are that a larger number of roads have adopted the new 1909 wheel than have previously purchased wheels made to the M. C. B. design. We learned from the manufacturers that they are rapidly getting in position to furnish the new wheel with the revised tread and flange, and that their orders justify making the change as rapidly as possible.

In view of the fact that the 1909 wheel has been so favorably received and that nothing has occurred to justify considering a change in the design, the committee has no recommendations to make covering the wheels or specifications.

We have received some communications during the year requiring attention, which have been handled as follows:

Attention has been called to the maximum flange thickness gauge, Sheet M. C. B.—16, not showing sufficient dimensions to accurately lay out the gauge. To correct this, a new drawing of the gauge, which is not changed, but has additional dimensions is presented.

The committee finds that there is no maximum allowable height of flange specified for cast-iron wheels, so as not to damage track crossings and frog filling blocks, and would recommend for this dimension 1½ inches, which is the same as has already been adopted for steel and steel-tired wheels, as shown in cuts on pages 98, 99, 100 and 101 in the 1909 Interchange Rules.

The attention of the committee has been called to the fact that brackets used on existing wheel circumference measuring tapes were made to conform to M. C. B. Standard tread and flange contour prior to modification of the 1907 convention, and it is the recommendation of the committee that these brackets be replaced with a form of bracket to suit the tread and flange contour adopted in 1909, and we enclose herewith drawing Fig. 2c. (not reproduced), showing the proposed new bracket, and recommend its adoption.

R. L. Kleine, chairman of the committee on standards and recommended practice, also forwards a letter relating to the diameter of new all-steel or steel-tired wheels, and the limit in diameter to which they should be turned when used in freight service. This is an important matter, which affects the trucks, brakes, height of couplers and interchange bills to an extent that the wheel committee feel is out of their jurisdiction, and suggest that it be handled by a special committee.

We have a communication from the Wheel Manufacturers' Association, which has been under consideration for several months, but can not recommend to the Association the adoption of the suggestions made, as we feel that it is unnecessary to have as a standard of the Association a special wheel weighing 675 pounds for exclusive use under 60,000-pound refrigerator cars when the 675-pound 80,000-pound capacity wheel, by a slight change in the core, can be used. The Manufacturers' Association also ask a modification of the present test requirements, which the committee can not see its way clear to recommend.

Discussion—Mr. Gibbs drew attention to the fact that the committee had not made any recommendation for limiting the variation in diameter. He considered this to be of pressing importance and believed the committee could easily handle it.

Mr. Cromwell explained that the committee had considered this matter late in the season and felt that it was of too much importance to be decided in so short a time. The president explained to Mr. Gibbs that the executive committee would take care of this subject by means of either another committee or by referring it back to this one.

The report was received and submitted to letter ballot.

DANGEROUS OXY-ACETYLENE APPARATUS

To the Editor:—

Believing that you are desirous of informing your readers correctly, concerning the bad practices which are resulting disastrously to the oxy-acetylene industry, you are requested to publish the following communication. Realizing that some of your readers may possibly consider that the statements were inspired by a selfish interest, we invite a most searching investigation as to their correctness:

If the union of oxygen and acetylene did not produce an unusually powerful agent, the oxy-acetylene process would not have its present value. Acetylene is by far the richest of all gases in carbon, and combined with oxygen, produces much the hottest flame that has yet been created. It is generated from calcium carbide, which is nothing more than coke and lime combined at a very high temperature, but the finished product is as inert, and as little dengerous, as crushed stone, unless put in contact with water, and it can be subjected to any kind of rough usage without the least danger. Acetylene itself cannot be ignited without a mixture of air, or oxygen, unless it is compressed to more than thirty pounds pressure.

Chemically, oxygen is made from chlorate of potash, and similar materials, which are not dangerous unless placed in contact with carbonaceous matter, so that neither carbide, acetylene, nor the chemicals, are at all dangerous if they are properly handled; improperly treated, they can be made exceedingly dangerous, just as can ordinary coal, or water gas, or any of the hydro-carbons, such as gasoline, or oil.

The present acetylene generator is the evolution of various types that have been tested by years of use, and most of the earliest processes have been discarded by responsible manufacturers. Hundreds of thousands of acetylene generators are in use in the United States, and have become so important in the lighting industry, that they are the subject of yearly inspection by a body of engineers, in a laboratory which has been established by the National Board of Fire Underwriters. These engineers have become experts in the generation of acetylene, and have prescribed rules for the construction of such generators, which are the outcome of years of constant examination of apparatus of this character. Generators built in accordance with these rules, can be accepted by the public as desirable types.

These engineers, and the experience of a number of reputable manufacturers, have demonstrated beyond qeustion, that what is known as the carbide-to-water types, are most desirable for the generation of acetylene. Carbide has what is termed "endothermic heat," which is similar to the heat of lime, when slaking, only the heat is much greater. One pound of carbide will boil six pounds of water; consequently the engineers for the insurance underwriters have a rule, requiring one gallon of water for each pound of carbide, which, it will be apparent, is sufficient to insure cool generation.

The types generally discarded are known as the water-to-carbide generators. The methods employed in this type were to sprinkle water on the carbide, or to flood compartments, or were of the recession type, where the water rose to the carbide and was forced back by the gas generated when the water came into contact with the carbide. All of these types are objectionable, because there is not a sufficient supply of water present for proper chemical reaction, and it is entirely absent so far as cooling is concerned. The result is that more or less gas is polymerized, or turned into tar vapors, by the excessive heat evolved locally, making a poor gas; and with a rapid generation, there is danger of the heat becoming so great as to melt the portions of the generator in contact with the carbide, and to create danger of explosion should the generator be opened when the carbide is in this heated condition. Generally, the carbide is in the interior of the generator, surrounded by water, so that the heat is not perceptible from the outside of the generator, but it exists nevertheless.

Attracted by the supposed profits in the sale of oxy-acetylene apparatus, a new crop of generator makers, who are either unfamiliar with the established methods of generation, or unscrupulous, are springing into existence, and are placing these undesirable types on the market. They are doing exactly what was done with lighting generators, in the earlier part of their history, until there became a great class of what was known as "tin can" machines, the poor results from which it took years of strenuous efforts by the better class of makers to overcome. These types of generators are even more objectionable for oxy-acetylene welding, than they were for lighting purposes, because the gas consumption is much more rapid, multiplying the bad effects from this improper generation. Should such generators be subjected to the inspection of the insurance engineers, they would unquestionably be promptly rejected.

Bad as is this method of gas generation, a still worse condition exists. It is known to those who are at all familiar with acetylene, that when it is compressed to from 30 to 45 pounds, or more, there is a kind of disintegration of the molecules, causing the gas to be explosive in the presence of a spark. In the early history of the art, some terrific explosions occurred from compressing acetylene in this form, and for a time its use under compression was entirely abandoned. Through a French discovery it was learned that if cylinders were completely filled with a porous material, and this material was then saturated with acetone, the acetone would dissolve the gas to twenty-five times its own volume for each atmosphere of pressure, and that when the pressure was relieved the acetone would give off the acetylene, and that this method not only gave the cylinders a marvelous capacity, but made it entirely safe to use acetylene in this form. The "Presto-o-lite" cylinders, which can be found on almost any automobile, are examples of what has been done in this line, and many railroad cars are lighted by this system. It is also employed quite extensively in oxy-acetylene welding for portable uses.

In the face of past disastrous experience, there are persons who are manufacturing acetylene by compressing it direct from carbide, without purification, and during the past year there have been several fatal accidents from this cause. In one case nine people were killed, and the directors of the International Acetylene Association held a special meeting, and passed resolutions condemning this process, which is nothing less than criminal to employ.

A method is being used to make apparatus portable, which is nothing more or less than to place an acetylene generator on an ordinary truck, and wheel it about. A generator in this position is not only likely to be accidentally tipped from the truck, but it may be placed in close proximity to red-hot furnaces, or struck by swinging cranes, or injured in many other ways, and it does seem as though any careful, thoughtful person could immediately realize the danger of such an arrangement. If the generator should be tipped over, it would immediately bring the whole body of water and carbide into contact, which would certainly burst the generator, and the volume of gas released might come into contact with fire, and an explosion follow. Obvious as is this danger, there are men in important mechanical positions to whom it did not occur until their attention was called to the possibilities. Certainly, no intelligent insurance representative would approve of such apparatus.

So far from acetylene being considered dangerous, when properly manipulated, the highest insurance authorities have concluded that it is much safer than movable units, such as lamps; and there is no reason why it should not be equally safe for oxy-acetylene purposes.

The conditions with regard to the generation of oxygen, are not much better. The desire of many persons, who can use the oxy-acetylene welding process to advantage, to obtain apparatus at very low cost, has proved to be a great incentive to constructing the apparatus cheaply.

Oxygen has been produced in this country for many years from chlorate of potash, and similar chemicals, but in such cases it has been the practice of the most prominent manufacturers to generate this gas under only sufficient pressure to wash it thoroughly, and force it into a gasometer, from which it is compressed by a compressor into tanks for portable use.

It does not require much thought to realize that it would be much cheaper to generate the oxygen in the retorts, under sufficient pressure to force it into the tanks ready for use. This would cut out large washers, the gasometer, and the most expensive part of the plant, the compressor; such a plant could be built at small cost, and at considerable profit. That this is being done, and advertised quite extensively, requires only the examination of the advertising columns of a number of trade papers to show.

The most approved types of plants generating oxygen from chemicals, have the compressors built with two stages of compression, with an intercooling coil between the cylinders, and with the cylinders totally submerged in water, so that even though there are impurities in the gas, there is not sufficient heat generated to ignite the mixture. It is also required that the parts of these compressors subjected to oxygen, must be of non-corrosive metal, which adds still further to their cost. It will be evident that plants not having these necessary requisites, can be, and are sold, for much less than properly constructed apparatus.

Defective and dangerous types of oxy-acetylene apparatus have not, as a rule, given satisfactory results and tend to discredit the process. Such apparatus has injured the art not only in this country, but in Europe as well. Solicitations have been received by the company which the writer represents, to sell its apparatus in Austria, by a very prominent firm, whose letter states that that country has numerous cheap and ineffectiv plants, which have brought the process into disrepute.'

Augustine Davis,
New York. President Davis-Bournonville Co.

UNIT SYSTEM OF ORGANIZATION ON THE UNION PACIFIC.

A circular issued by A. L. Mohler, general manager of the Union Pacific Railway, and approved by J. Kruttschnitt, director of maintenance and operation, announces the extension of the Hine unit system of organization to the general offices of the Union Pacific, and the former general superintendent, superintendent of motive power and machinery, chief engineer, superintendent of transportation, and assistant to the general manager have been appointed assistant general managers.

This system, as adopted in the general offices, is similar to that already in operation on most of the divisions of this railroad. The initial installation was made on the Nebraska division and the system and its purposes were fully outlined and described in a paper before the Western Railwav Club by the originator, Major Charles Hine, which appeared on page 106, March, 1910, American Engineer and Railroad Journal.

While at the time of its adoption it was regarded as an experiment it has worked out satisfactorily and will be further extended to all divisions as soon as details can be arranged. The general extension of the system, after about a year's trial, is an indication of its success and that it has become the fixed policy of the Harriman lines.

POSITIONS WANTED

Assistant to Superintendent of Motive Power or General Inspector.—Man with 20 years' railroad experience; technical education; has held all positions, from fireman to master mechanic, and from machinist to mechanical engineer; a hustler who can show results; is an expert on fuel tests, spark throwing, front end and draft arrangements.

Supt. of Construction, Installation Engineer, Engineering Salesman, Inspector.—Graduate in mechanical engineering, later special student in electrical engineering; over ten years' experience, East and West; railroad work, from shops to Assistant Engineer; experience with large engineering works and with consulting engineers. Preferred location, Pacific Northwest; installation, erecting, testing of machinery; steam or hydro-electric power plants, shops and mills, electric traction, irrigation pumping plants; some acquaintance with concrete.

BOOK NOTES.

Lubrication of Steam Engines. By T. C. Thomsen. Cloth. 5 by 7½. 97 pages. Illustrated. Published by The Technical Publishing Co., 55 Chancery Lane, W. C., London. Price, 60 cents.

This book confines itself principally to internal lubrication and goes very fully into a discussion of the chemical and physical properties of cylinder oils, the standard grade of oils and the different types of lubricators. It discusses the internal lubrication of all different types of steam engines using both saturated and superheated steam. One chapter is devoted particularly to locomotives. The dangers of the presence of cylinder oil in boiler feed water is discussed and oil separators are considered at some length. It is a very complete discussion of this important subject.

"Self Taught Mechanical Drawing and Elementary Machine Design." By F. L. Sylvester, M. E., and Erik Oberg. Cloth, 333 pages, 5 x 7¾ in. Illustrated. Published by the Norman W. Henley Pub .Co., 132 Nassau street, New York. Price, $2.00.

This is a very practical treatise on Mechanical Drawing and Machine Design, comprising the first principles of drawing, workshop mathematics, mechanism and the calculations and design of machine details. It is especially prepared for the practical mechanic and the young draftsman.

PERSONALS.

G. I. Evans, chief draftsman of the Canadian Pacific Railway at Montreal, Quebec, has been appointed mechanical engineer.

C. E. Fuller, superintendent of motive power and machinery on the Union Pacific Railroad, has been appointed assistant general manager under the new organization system.

Don B. Sebastian, acting fuel agent of the Chicago, Rock Island and Pacific Ry., has been appointed fuel agent, with headquarters at Chicago, Ill.

Walter E. Dunham, master mechanic of the Chicago and Northwestern Ry. at Winona, Minn., has been promoted to supervisor motive power and machinery, with offices at the same place.

J. D. Harris, general superintendent of motive power of the Baltimore & Ohio R. R. Co., with offices at Baltimore, Md., has had his authority extended over the Baltimore & Ohio Southwestern Railroad.

The office of master mechanic on the Chicago, Peoria & St. Louis Railway has been abolished and C. S. Branch has been appointed superintendent of the mechanical department, with office at Jacksonville, Ill.

J. F. Killeen has been appointed general mechanical foreman of the Washington division of the Oregon Railroad & Navigation Co., with office at Starbuck, Wash., succeeding M. J. Carrigan, resigned.

T. H. Goodnow, who was recently promoted to master mechanic of the Lake Shore and Michigan Southern Ry. at Elkhart, Ind., has resumed the former office of master car builder at Englewood, Ill., succeeding J. W. Senger, transferred.

Joseph Smith Harris, former president of the Philadelphia & Reading Railway, died suddenly on June 2, at his home in Germantown, Pa., from apoplexy. Mr. Harris was born in Chester

County, Pennsylvania, on April 29, 1836, and entered railway service in 1853, since which time he has been consecutively rodman and topographer, North Pennsylvania Railroad; in command of U. S. Steamer *Sachem,* attached to Farragut's Mississippi River Squadron; engineer of the Lehigh & Mahanoy Railroad; chief engineer Morris & Essex Railroad; chief engineer Philadelphia & Reading Coal & Iron Co.; superintendent and engineer Lehigh Coal & Navigation Co.; general manager Central Railroad of New Jersey; president Lehigh Coal & Navigation Co.; receiver and afterward vice-president of the Central Railroad of New Jersey; vice-president of the Philadelphia & Reading Railway; receiver and president Philadelphia & Reading Railway; president of the reorganized road, the Reading Co., Philadelphia & Reading Railway, and the Philadelphia & Reading Coal & Iron Co.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Pipe Unions.—The Jefferson Union Company, of Lexington, Mass., has recently prepared catalogs on their style F male and female unions and on their new swing union, which is practically universal. These will be sent on request.

Ball Bearing Line Shaft Hangers.—The Hess-Bright Mfg. Co., Philadelphia, Pa., is sending out sheets for their loose seaf binder on the above subject, giving dimensions of hangers for various loads.

Induction Motors.—The Sprague Electric Co., 527 West 34th St., New York, is sending out a large illustrated bulletin, No. 600, describing a variety of single and polyphase induction motors, including a number of efficiency curves and wiring diagrams.

Railroad Wrench.—The Uwanta Wrench Co., Meadville, Pa., has recently sent out a small circular describing the "Uwanta" wrench. This wrench is said to be a one-piece drop forging and very strong.

Friction Clutches.—A very artistic catalog describing and illustrating friction clutches for various purposes is being sent out by the Hill Clutch Co., Cleveland. O. These clutches have been in use for heavy work on elevating, conveying and cement machinery.

Conveying Machinery.—A new and complete catalog has recently been sent out by The C. W. Hunt Co., 45 Broadway, New York City, describing coal handling and hoisting machinery, conveyors and equipment for locomotive coaling stations.

Motor Inspection Cars.—The Buda Company, Chicago, is sending out an artistic and interesting catalog, which is well illustrated, showing their gasolene motor inspection cars for railroad work. These cars are made with a capacity for six passengers.

Pneumatic Hammers.—A new bulletin recently sent out by the Ingersoll Rand Company, 11 Broadway, New York, describes the imperial, type E pneumatic hammers, with sectional diagrams, showing the construction of these new tools.

Radial Drill.—The Mueller Machine Tool Co., Cincinnati, O., is issuing a number of new sheets for its loose leaf binder, with illustrations and description of their new standard radial drills, with 2½ to 4½ ft. arms.

Battery Charging Rheostats.—An interesting booklet of 42 pages with the above title has just been published by The Cutler-Hammer Mfg. Co., of Milwaukee. It describes this company's entire line of battery charging rheostats, comprising two types for charging ignition batteries and six types for general charging work, for electric pleasure vehicles and for trucks. Full page illustrations of the various types are shown besides several special types such as a motor-generator set panel and a panel for use with a gas engine driven dynamo and storage battery. The method of tabulating data and list prices is worthy of comment, all information being condensed into a single table.

Tungsten Lamps.—Bulletin No. 4739, just issued by the General Electric Company, Schenectady, N. Y., describes the "G.E." Mazda incandescent lamp, which has an improved tungsten filament and gives the high efficiency of 1 to 1¼ watts per candle power. In other words, the Mazda lamp divides the cost of current by three, or gives three times as much light for the same expenditure of energy. The bulletin describes this lamp in great detail, and illustrates the various sizes of this type of lamp for use on multiple circuits. It contains tables showing cost of operation and life, effect of voltage variation on candle-power and watts, relative costs of lighting with various lamps for equal illumination, etc., and also devotes considerable space to the reflectors necessary to give the best results.

NOTES.

Railway Supply Manufacturers' Association.—This association, with J. D. Conway as secretary, announces the removal of its offices from 313 Sixth avenue, to Room 2135, Oliver Bldg., Pittsburgh, Pa.

Falls Hollow Staybolt Co.—This company, of Cuyahoga Falls, O., advises that H. W. Davis, No. 2 Rector street, New York, has been appointed its Eastern representative.

B. F. Sturtevant Co.—It is announced by the above company that they inaugurated a new custom last June by holding their salesmen's convention at Hyde Park, Mass., at which the branch office managers and principal salesmen all over the country assembled.

Walter B. Snow, Publicity Engineer, Boston, Mass., announces that H. Ross Callaway, a graduate of the Massachusetts Institute of Technology, and late assistant to the mechanical engineer of the New York Edison Co., has been added to his staff.

Worcester Machine Screw Co.—The above company, of Worcester, Mass., announces the death of Edward Blake Dolliver, treasurer of the Standard Screw Company and manager of the Worcester Machine Screw Company.

Baldwin Locomotive Works.—Wm. L. Austin has been made president of the above company, succeeding John H. Converse, whose death was recently announced in these columns. Mr. Austin was formerly vice-president of the Baldwin Company and has been chief draftsman of the company for some time.

C. W. Hunt Company.—The above company, builders of coal handling, conveying and hoisting machinery, whose address is West New Brighton, N. Y., have opened offices in the State Bank Building, Richmond, Va., and also 607 Rhodes Building, Atlanta, Ga., in charge of W. F. Lee, for several years preliminary engineer to the company. C. T. Anderson has been appointed manager of the Chicago office, 1616 Fisher Building.

Detroit Seamless Steel Tubes Co.—This company announces the appointment of H. S. White as sales manager at Detroit, Mich. Mr. White's experience in the seamless tube field began in 1897 in the commercial department of the Pope Tube Co. in Hartford, Conn. From there he went to Cleveland as assistant general sales agent for the Shelby Steel Tube Co. at the time the former company was absorbed by the Shelby Tube Co. In 1903, after the absorption of this company by the National Tube Co., he became general manager of sales of the National Tube Co. in charge of the seamless steel product and was appointed to his present position on April 15, 1910.

Allis-Chalmers Company.—David Van Alstyne has been elected vice-president in charge of manufacturing of the above company, with headquarters at Milwaukee, Wis. Mr. Van Alstyne is specially well fitted for this work, and is one of the few men who understand thoroughly and know how to apply successfully, the principles underlying economical and efficient production on a large scale. He began work as a machinist on the Louisville & Nashville and was later master mechanic on the Louisville, Henderson & St. Louis Ry., superintendent of motive power on the Chicago Great Western RR. and mechanical superintendent on the Northern Pacific. His splendid work on these two roads attracted attention to his qualities as an executive and manager, and in 1907 he was elected vice-president in charge of manufacture of the American Locomotive Company. During the past few months he has been retained in a consulting capacity for a western railway system.

J. G. White Company.—It is announced that L. R. Pomeroy, who recently resigned the position of assistant to the president of the Safety Car Heating and Lighting Co., has been appointed chief engineer of the railway and industrial division of the above company in New York City. Mr. Pomeroy has for a long time been considered an authority on railway shop equipment, operation and construction, and is peculiarly adapted both by nature and training for his new work. Beginning in 1874 he was engaged successively in the commercial business; special auditing; drafting and designing of cars and locomotives. Then he was secretary and treasurer of the Suburban Rapid Transit Company of New York, and later a special representative of the Carnegie Steel Company and Cambria Steel Company, introducing basic boiler steel for locomotives and special forgings for railways. This assignment involved metallurgical engineering and experimental research to adapt special steels for railway axles, crank pins and piston rods. From 1899 to 1902 he was assistant general manager of the Schenectady Locomotive Works, and for six years following this he was a special representative in the railway field for the General Electric Company, this work covering the electrification of steam roads, railway shops and the general application of electricity for all railway purposes. For the past two years he has held the position with the Safety Car Heating and Lighting Company, which he resigned to take up his new work. While holding the last position, Mr. Pomeroy also devoted a portion of his time to consulting work in the special field of railway shops and machine tool operation.

ARTICULATED COMPOUND LOCOMOTIVES. 0-8-8-0 TYPE

NORFOLK AND WESTERN RAILWAY.

In addition to the five locomotives built by the Baldwin Locomotive Company, which were illustrated on page 269 of the July issue of this journal, the Norfolk & Western Railway is also receiving from the American Locomotive Company five engines of the same general type.

Inasmuch as great freedom was allowed the builders, in both of these orders, to use their own judgment as to general arrangement, and as both orders were built to cover practically the same specifications as to the work to be performed, the two designs illustrate the differences of opinion between the builders very clearly. The Baldwin locomotives are of the 2-8-8-2 type, having a total weight of 390,000 lbs., of which 360,000 is on drivers. The American locomotives are of the 0-8-8-0 type and weigh 375,000 lbs. total, all of which is on the drivers. Outside of this different wheel arrangement, the chief difference is found in the boiler construction. The fire box in both cases is practically the same, but in the Baldwin locomotives there are 350 2¼ in. tubes, 21 ft. long, which terminate in the combustion chamber, ahead of which is a feed water heater having 450 tubes 63 in. long and in the front end is a Baldwin superheater arranged as a reheater The boiler is of the separable type, the joint coming at the combustion chamber. On the order here illustrated the boiler is simply and entirely a steam generator, having 367 2¼ in. flues, 24 ft. long, which end in the smoke box in the usual manner.

In the method of steam control is another noticeable difference. The Baldwin engines exhaust directly into the receiver pipe from the high pressure cylinders and provide simply a 1¼ inch pipe connection, with a globe valve in the cab, for furnishing steam to the low pressure cylinders in starting. This pipe connects to the receiver pipe, and its small size is depended upon to sufficiently reduce the pressure. The American locomotives are compounded on the Mellin system, which includes an automatic intercepting valve that admits steam at reduced pressure to the receiver as soon as the throttle is opened and automatically closes when the exhaust from the high pressure cylinders builds up the receiver pressure to the proper point. It can also be opened for the purpose of increasing the receiver pressure or "simpling" whenever desired.

These three features—*i. e.*, wheel arrangement, boiler construction and system of compounding—are the chief points wherein the two builders entertain different opinions, and an opportunity will be given the Norfolk & Western Railway to determine the relative value of the two arrangements, which it is hoped will assist in settling the differences of opinion which now seem to generally exist among railroad men as to the relative value of the two types.

These locomotives, while intended principally for use on the division between Columbus, O., and Roanoke, Va., a distance of 449 miles, on which there is a grade of 2 per cent. with some very sharp curves, will also be put into service, it is expected, on the main line between Norfolk and Bristol, a distance of about 408 miles, where a good opportunity is offered for obtaining the full advantages of the Mallet types, the grades on this section being from 1 to 1.3 per cent.

Referring to the locomotives built by the American Locomotive Co., the design is in general very similar to the enormous engines, six of which were recently delivered by these builders to the Delaware & Hudson Company, being illustrated on page 207 of the June issue of this journal. They are somewhat smaller than that design, however, and although the boiler tubes are the same length in each case, the Norfolk & Western locomotive does not have a combustion chamber. Also on account of the smaller boiler it was not necessary to follow the arrangement of steam piping required on the Delaware & Hudson engine and the high pressure steam is carried directly from the dome to the valve chamber in the usual manner.

A modification from the builder's former practice for articulated type of locomotives is found in the arrangement of the reversing connection to the low pressure engine, where a scheme similar to that on the Baldwin engines is used. This consists of carrying the connection between the high and low pressure reversing shafts between the frames, and providing it with a universal joint at the high pressure cylinders saddle. This arrangement eliminates the necessity of using universal joints in the radius bar hangers and does not give as great a disturbance in the valve elements when curving.

LOCOMOTIVE DESIGNED BY THE AMERICAN LOCOMOTIVE COMPANY FOR THE NORFOLK AND WESTERN RAILWAY.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	85,000 lbs.
Weight in working order	375,000 lbs.
Weight on drivers	375,000 lbs.
Weight of engine and tender in working order	433,600 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, total	41 ft. 2 in.
Wheel base, engine and tender	72 ft. 10 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.42
Total weight ÷ tractive effort	4.42
Tractive effort × diam. drivers ÷ heating surface	857.00
Total heating surface ÷ grate area	71.00
Firebox heating surface ÷ total heating surface, %	3.95
Weight on drivers ÷ total heating surface	69.70
Volume equivalent simple cylinders, cu. ft	25.50
Total heating surface ÷ vol. equiv. cylinders	210.00
Grate area ÷ vol. equiv. cylinders	2.96
CYLINDERS.	
Kind	Compound
Diameter	24½ & 39 in.
Stroke	30 in.
VALVES.	
Kind, H. P	14 in. Piston
Kind, L. P	Slide
Greatest travel	6 in.
Outside lap, H. P	1 in.
Outside lap, L. P	⅞ in.

Inside clearance	3/16 in.
WHEELS.	
Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10 x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	83⅞ in.
Firebox, length and width	120⅛ x 98¼
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F. 5½, S. & B. 5 in.
Tubes, number and outside diameter	367—2¼ in.
Tubes, length	24 ft.
Heating surface, tubes	5,167 sq. ft.
Heating surface, firebox	212 sq. ft.
Heating surface, total	5,379 sq. ft.
Grate area	75.3 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 5 11/16 in.
Center of boiler above rail	120 in.
TENDER.	
Tank	Water Bottom
Frame	15 in. Center, 12 in. Side Sills
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons

EQUALIZATION OF MALLET ARTICULATED LOCOMOTIVES.

BY W. E. JOHNSTON.

It seems to have been the practice in this country in designing Mallet articulated locomotives, to equalize all the driving springs of the front engine together and with the leading truck if one is used. This arrangement gives practically a three-point support to the boiler and prevents local stresses of a diagonal nature on uneven track, or when entering or leaving curves on which the outer rail is elevated. The stability of the locomotive is, however, very materially reduced by this arrangement, possibly to a dangerous extent with certain spring rigging arrangements on the back engine.

Figure 1 shows the situation on an engine of the 2-8-8-2 type equalized according to the usual method and with the back end of both trailer equalizers resting on a single cradle casting in the trailer truck. Considering only the boiler, rear engine frame, high pressure cylinder and such parts as are rigidly attached thereto, ABC is the three point or triangular support and CG the center of gravity. The stability of the locomotive then depends on the distance of the center of gravity from the sides AC and BC of the triangle. The width of the base AB of the triangle depends on the spring arrangement of the rear engine, and is equal to the distance between frames on engines without trailing trucks.

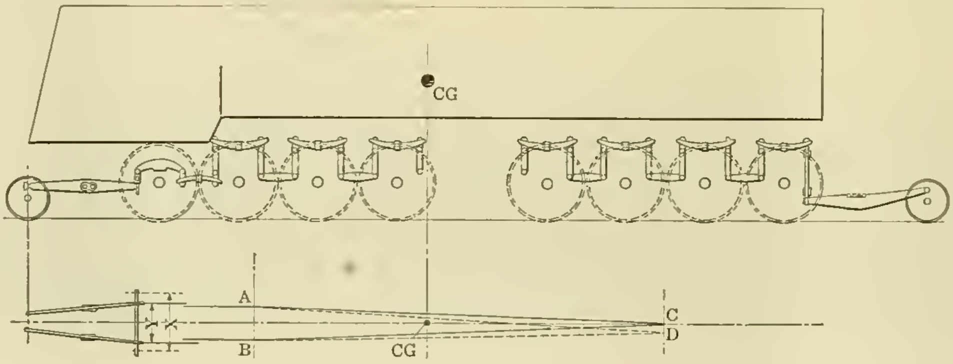


FIG. 1.

On engines with trailing trucks using a transverse equalizer as shown in Figures 1 and 2, the width $AB = \frac{W1}{W2} \times Y$ where Y is the distance between the points at which the trailer equalizers bear on the transverse equalizer, W_1 = weight on driving springs of rear engine and $W_2 = W_1$ plus weight on trailer springs.

This is due to the fact that the transverse equalizer will turn about one of the bearings for the trailer equalizers as a fulcrum if the turning moment due to the difference in weight on opposite sides of the engine resulting from centrifugal force or other causes, exceeds the maximum turning moment which the trailer equalizers can exert in the opposite direction. The total pressure of the two trailer equalizers on the transverse equalizer is obviously equal to the upward pull of the driving spring hangers or $P + P'$, Fig. 2.

This may all be concentrated on one equalizer. $\frac{Y}{2}(P + P')$ then will equal the maximum turning moment the trailer equalizers can exert to prevent rotation of the transverse equalizer, and also the maximum turning moment due to inequalities in weight on opposite sides of the engine.

If the distance between the front end of the trailer equalizers is made equal to the distance between the driving springs with or without a transverse equalizer the turning moment will be $\frac{X}{2}(P + P')$, Figure 2, in which X equals the distance between the frame centers.

The factor $\frac{W1}{W2}$ of the equation $AB = \frac{W1}{W2} \times Y$ applies only to locomotives having the rear end of both trailer equalizers resting on a common support as in the case of trailer trucks in which a single cradle casting acts as a combined truck center pin, swing bolster and equalizer support. With this arrangement, the trailer springs do not assist in righting the engine as the load from the trailer equalizers is carried on the cradle near the center of the engine and the trailer acts as a single point of support. The effect of carrying a portion of the weight of the rear engine on a support at the center of the engine is, obviously, to reduce the resistance to rolling in the same proportion, or about ten per cent. in ordinary 2-8-8-2 designs.

In Figure 1, if Y = 25½", AB equals about 23" and the distance from the center of gravity to the sides AB and BC of the triangle will equal 6½". This will be the condition on straight track. On curves, however, the center of bearing pressure between the boiler and the front engine is on the center line of the engine frame and on a curve to the right, ABD, shown dotted, would become the triangle of support instead of ABC.

On a 10° curve CD equals about 8", then the distance from the center of gravity to the side AD will equal about 3¼", giving an extremely small margin of safety.

The distance between centers of the driving bases of the front and rear engines will not be more than about 25 feet for 0-8-8-0 and 2-8-8-2 types, and the difference between the elevations of the outer rail in this distance will not usually exceed ¼".

Heavy engines of these types must necessarily have good and substantial track. The necessity for three point support, therefore, seems to be largely imaginary and of much less importance than the increased stability to be gained by changing the equalization.

Figure 3, herewith, shows a spring rigging arrangement for engines of the 2-8-8-2 type. This gives five points of support for the parts above the springs, but each of these five points of support has from three to five points of support on the rails, so

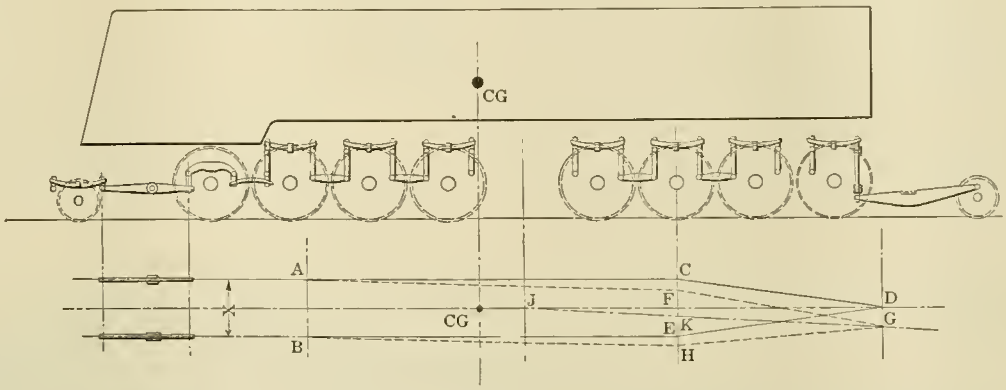


FIG. 3.

that the effect of low spots in the track at rail joints, at edges of the turntable or other inequalities will be distributed between enough springs so as not to have any injurious effect.

In Figure 3 the polygon ACDEB represents the five point support for the parts above the springs. The distance of the center of gravity from the edge of the support would be 21½" on an engine with 43" frame centers standing on straight track. On a 10° curve the distance would be about 18½", and the distances from the center of gravity to the side of the support with the arrangement as shown in Figure 3 are therefore equal to ap

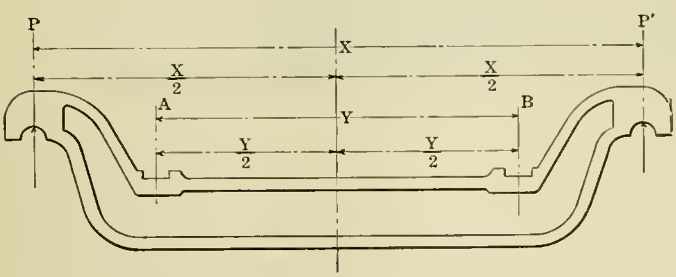


FIG. 2.

proximately 3 to 5 times the corresponding distances in Figure 1, the increase in ultimate stability being proportional.

The spring rigging arrangement for the front engine shown in Figure 3 is known to be entirely practical and satisfactory, as it is now in use on some engines originally equalized like Figure 1, which gave trouble from the springs of the front engine getting out of their proper positions.

HORSEPOWER REQUIRED FOR MACHINE TOOLS.

The determination of the horsepower required for driving machine tools calls for the exercise of considerable judgment, especially in the case of alternating current motors where a power factor enters into consideration. Exhaustive tests have been made to determine the amount of power required to drive tools, but it is to be regretted that many of these tests are lacking in essential features that would make them valuable. Conclusions drawn from incomplete data are apt to be misleading; as in the case of tests made with motors which are considerably underloaded or overloaded, and where efficiencies are not taken into consideration; or where the material used and duration of test are not stated; or where there has been failure to state whether the test was a practical one or merely a breakdown test. The conclusions drawn from breakdown tests are often deceptive and should not be used for determining power to drive tools; also it does not follow that a tool which stands up longer than another under breakdown conditions, will do the same under practical conditions. The majority of the formulas now in existence for computing horsepower required for tools are generally misleading and useless, and no general formula that would be of practical value has been developed, as the power required varies with the metal worked, the cutting speed and many other conditions.

The construction of the tool is seldom taken into consideration when estimating horsepower, yet some of the worm-driven tools are notoriously inefficient. Other tools are so constructed that the greatest part of the power delivered to the tool is consumed in friction losses and not in useful work; again, the tool may be constructed upon approved lines but may not be stiff enough to stand the strains to which it is subjected, thereby causing considerable loss of power, all of which, as well as the difference in power due simply to the shape of a cutting tool, has been repeatedly proved by tests. In one instance, it required 72 per cent. more power to drive a plain spiral milling cutter than the same cutter nicked.

The advent of the high-speed steel and the high-power tools, together with the increased speed of old tools, makes much of the data bearing on horsepower collected up to a comparatively short time ago, of somewhat doubtful value. From the above, and from the fact that the duty required of a tool in one shop may be more severe than that in another, it will be seen that it cannot be accurately stated that a definite size of motor is required for a given tool. In the majority of cases, however, the horsepower for small tools has been pretty well fixed. With the larger tools the variation in horsepower required is much more pronounced, and at the same time is more important on account of the size of the motors involved. This variation in horsepower is often as much as 4 to 1 and sometimes even 6 to 1.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

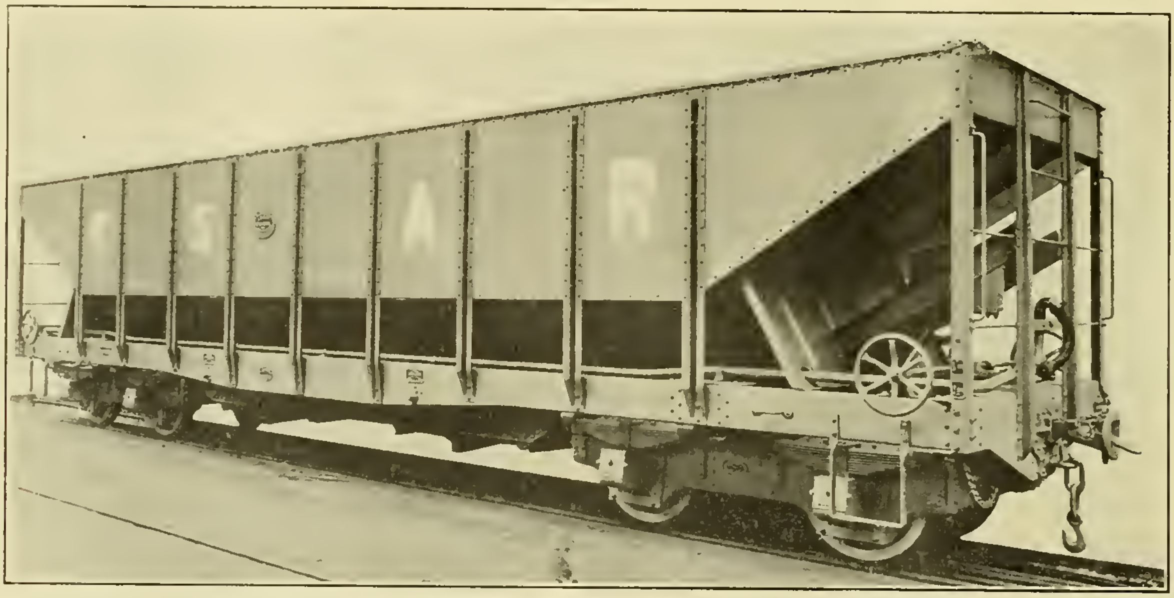
United States Bureau of Mines.—This new bureau was established July 1 with the transfer from the Geological Survey to the bureau of all work relating to mine and fuel investigation and including the fully equipped testing station at Pittsburgh. The publications of the Survey relating to mine and fuel investigations will in the future be distributed by the Bureau of Mines, the last bulletin of the Survey, "The Explosibility of Coal Dust," by G. S. Rice, being issued about August 1. Following this the Bureau of Mines will issue *"Volatile Matter of Coal"*; *"Coal Analysis,"* by N. W. Lord; *"Final Data Regarding Steam Tests,"* by L. P. Breckenridge; *"North Dakota Lignite as a Boiler Fuel," "Producer Gas Tests in 1905-07," "The Coke Industry as Related to the Foundry," "Coal for Eliminating Gas,"* and *"Petroleum as Fuel for Boilers."* The newly created Federal bureau is about to make up a permanent mailing list of those interested in receiving news concerning its work and copies of the bulletins, and all persons who care to have their names on the list are requested to notify the Director of the Bureau of Mines, Washington, D. C.

100,000 LB. NARROW GAUGE HOPPER CAR.

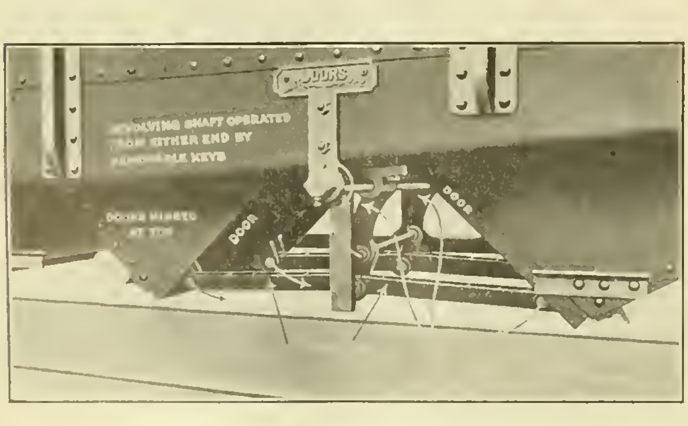
CENTRAL SOUTH AFRICAN RAILWAY.

For use in the coal traffic in the Rand district around Johannesburg, the Central South African Railways has purchased five experimental self-discharging hopper cars, designed and built by the Leeds Forge Company, Limited, of Leeds (England). This company has also during recent years built two hundred and fifty 85,000 lb. capacity all-steel hopper cars for this road. The Central South African Railway is 3 ft. 6 in. gauge and these cars are said to be the largest freight rolling stock which has yet been constructed for any narrow gauge railway system.

From the illustration, it will be seen that the body of the car, which is constructed throughout of steel, is carried on Fox's patent pressed steel underframe, the latter being carried at either end on the spherical centers of two four-wheel trucks, also of the Fox pressed steel pattern. The Leeds Forge Company's patent arrangement of the inside stanchions has been adopted in order to give the minimum overall dimensions. The cars are arranged so as to discharge the whole of the contents at the center, and the doors can be opened and closed from either side of the car by turning the transverse shaft. This shaft carries levers fixed to it which are connected by links to toggles, the bottom ends of which are attached to the door. These toggles are so arranged that when the doors are closed they are in line with each other, and they thus resist any tendency of the doors to open through the action of the load on the doors, or as a result of switching operations. The cars are fitted with an either-side handscrew brake, applying brakes to all wheels, and are fitted with the buffer gear common to the C. S. A. system.



100,000 LB. STEEL HOPPER CAR FOR 3 FT. 6 IN. GAUGE RAILROAD.



DETAIL OF DOOR OPERATING MECHANISM.

The following are some of the leading dimensions:

Length over buffers	42 ft. 9 in.
Length inside	40 ft.
Width over all	8 ft. 4 in.
Width over headstocks	8 ft. 2⅜ in.
Width inside	8 ft. 2 in.
Total height	10 ft.
Wheels, diameter	2 ft. 10 in.
Truck wheelbase	5 ft. 6 in.
Centers of trucks	28 ft. 6 in.
Buffer height (unloaded)	2 ft. 11 in.
Centers of journals	5 ft. 6 in.
Net capacity	1,700 cu. ft.
Load	100,000 lbs.
Weight	40,880 lbs.

STATISTICS OF RAILROADS.

The preliminary abstract of the report of the Interstate Commerce Commission on the statistics of railways in the United States for the year ending June 30, 1909, contains the following information: On June 30, 1909, there was a total single track mileage of 236,868.53, an increase of over 3,000 miles from the previous year. The number of railways included in the report is 2,196. There were 57,212 locomotives in service at that date, an increase of 479 over the previous year. Of these 13,317 are passenger, 33,935 freight, 8,837 switching, the remainder being unclassified. The total number of cars of all classes are 2,218,280, or about 13,000 less than the previous year. The average number of locomotives per thousand miles of line was 243, and of cars 9,423. The total number of employees on steam roads was 1,502,823, an average of 638 per 100 miles of line. This does not include the employees on switching and terminal companies, which are not considered in any of the summaries. The total capitalization at par value was $17,487,868,935, representing a capitalization of $59,259 per mile of line. During the year there were 253 passengers killed and 10,311 injured. Of these, however, but 86 passengers were killed and 4,805 injured because of collisions or derailments. The total number of persons other than employees or passengers killed was 5,859, injured 10,309.

NEW CHICAGO AND NORTHWESTERN TERMINAL.—The new Chicago terminal of the Chicago & Northwestern Railroad has progressed far enough to give an idea of the remarkably attractive and imposing appearance which the finished structure will present. The station building and train shed occupy an area of 320 by 1,290 ft., all buildings covering 20 acres of ground. The tracks in the train shed have a capacity of 200 cars. The total daily capacity of the whole station will be 250,000 passengers which can be handled without any confusion or crowding. The building contains all possible facilities and conveniences for travelers.

OPERATION OF MALLET COMPOUNDS IN PUSHER SERVICE

DELAWARE & HUDSON CO.

On page 207 of the June issue of this journal appeared an illustrated description of some very powerful Mallet locomotives of the 0-8-8-0 type, six of which had been delivered to the Delaware and Hudson Co. by the American Locomotive Company. These locomotives were designed to take the place of two very large pusher engines which it had been necessary to use on the grade out of Carbondale, Pa.

After they had been in service for a short time, some comparative test runs were made to determine the exact cost of operating on this grade under the two methods. Four runs were made with the same two pushers of the class E-5 type,* then four runs with one of the Mallets, followed by four more with another Mallet. The tonnage of all trains was practically the same. Observations were taken and determinations made of the number of cars handled by the pusher alone, the steam pressure, coal burned, draft, water consumption, etc. These are given in the table below.

It will be seen from the results that one Mallet performed almost exactly the same work as two of the E-5 engines with a saving of about 44 per cent. in coal and 27 per cent. in water. Since the coal used on the Mallets was not as expensive a grade the results are all the more striking.

Some of the general dimensions, weights, etc., of the two classes are given below:

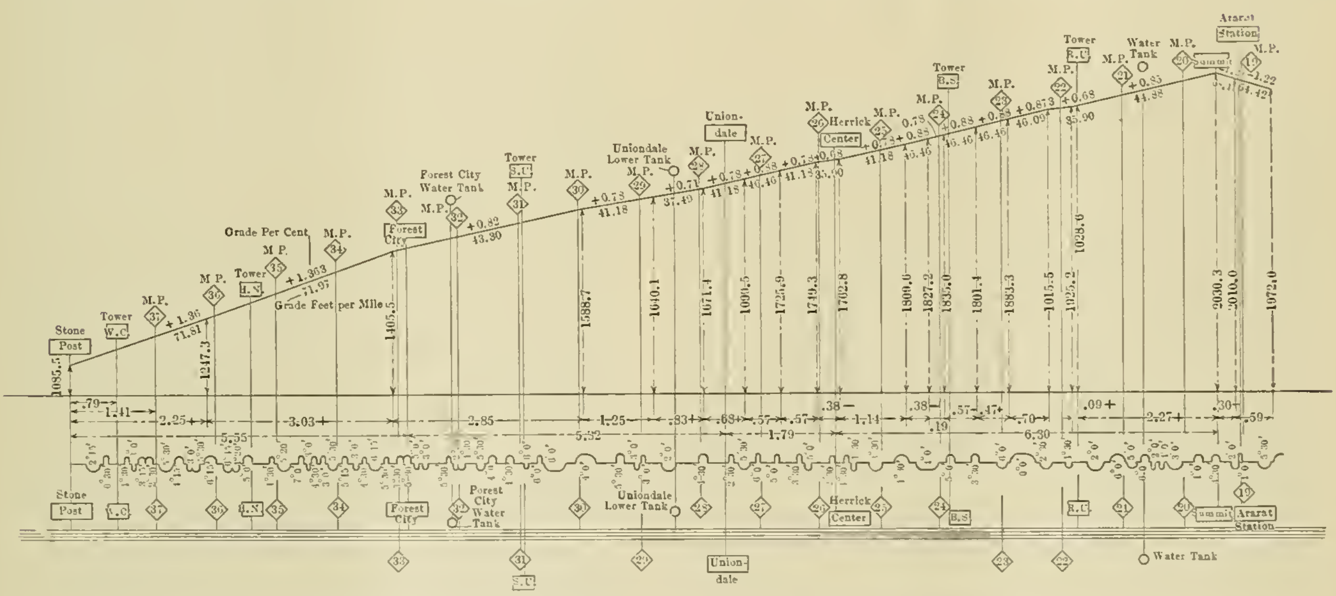
Class	E 5	H
Type	2-8-0	0-8-8-0
Weight, total, lbs.	246,500	445,000
Weight, drivers, lbs.	217,500	445,000
Tractive effort, lbs.	49,690	105,000
Diameter drivers, in.	57	51
Steam pressure, lbs.	210	220
Cylinders, diameter, in.	23	26 & 41
Cylinders, stroke, in.	30	28
Boiler, diameter, in.	83¾	90
Tubes, number and size	493—2	446—2¼
Tubes, length	14 ft. 6 in.	24 ft.
Grate area, sq. ft.	99.85	99.85
Heating surface, total, sq. ft.	4,045.5	5,629

The average results of four runs with two class E-5 and eight runs with the Mallets (four with each) are as follows:

No. of locomotives	2	1
Class	E 5	H
Type	2-8-0	0-8-8-0
Cars in train	44.8	45
Handled by pusher	30.3	30.1
Actual tonnage of train	2,279.3	2,275.6
Tonnage moved by pusher	1,504	1,490.8
Percentage moved by pusher	65.99	65.48
Running time—W. C. Tower to Forest City	38 min.	45.5 min.
" " Forest City to Uniondale	18.8 min.	21.8 min.
" " Uniondale to Summit	46 min.	43.1 min.
" " W. C. Tower to Summit	1 hr. 42.8 min.	1 hr. 50 min.
Miles per hour—W. C. Tower to Forest City	7.52	6.28
" " " Forest City to Uniondale	14.20	12.25
" " " Uniondale to Summit	11.69	12.47
" " " W. C. Tower to Summit	10.51	9.88
Average steam pressure—		
W. C. Tower to Forest City	200.	203
Forest City to Uniondale	191.5	199
Uniondale to Summit	198.5	199
W. C. Tower to Summit	196.5	200
Pounds of coal burned—		
W. C. Tower to Forest City	6,281	3,784
Forest City to Uniondale	4,540	2,572
Uniondale to Summit	8,253	4,273
W. C. Tower to Summit	19,074	10,629
Kind of coal*	——	——
Pounds of coal per hr. per sq. ft. grate area	55.8	57.9
Draft, inches water—Front of diaphragm	——	6.21
" " " Back of diaphragm	——	4.31
" " " Firebox	——	2.30
" " " Ash pan	——	.29
Gallons water used—W. C. Tower to Forest City	4,334	3,233
" " " Forest City to Uniondale	2,811	2,056
" " " Uniondale to Summit	5,496	3,915
" " " W. C. Tower to Summit	12,644	9,205
Coal burned per 1,000 ton miles	.349	.196
Cost per 1,000 ton miles	.768	.431

* E 5 pushers used a mixture of pea 50 per cent., buckwheat 40 per cent., soft 10 per cent. The Mallets used a mixture of pea and soft which averaged, pea 48.75 per cent., soft 51.25 per cent.

* See AMERICAN ENGINEER, January, 1907, page 22.



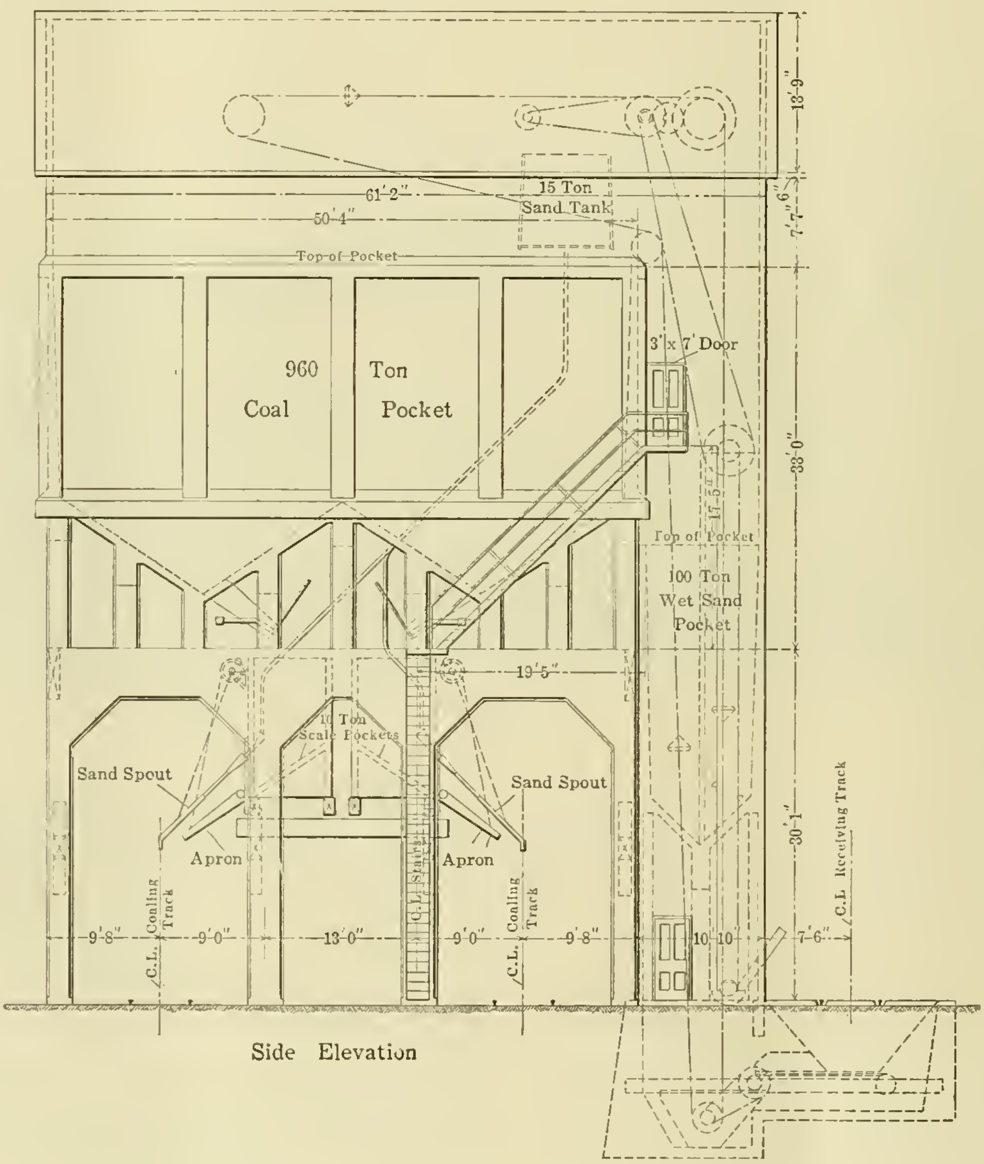
PROFILE OF LINE FROM W. C. TOWER TO SUMMIT—D. & H. CO.

Growth of Pension Systems.—With the beginning of the year, 165,000 railroad employees have been added to the 500,000 in this country to whom pension plans already apply. This large increase is due to the action of the New York Central and Rock Island lines, which have announced the installation of pension departments. The latest government report on the number of railroad employees puts the total for the country at 1,672,074. Of these approximately 665,000, or about 40 per cent., serve the roads which have pension systems. Companies that now bestow pensions on employees are the New York Central, the Rock Island, the Pennsylvania, the Buffalo, Rochester and Pittsburgh, the Chicago and Northwestern, the Illinois Central, the Santa Fe, the Union Pacific, the Southern Pacific and its affiliated lines, the Lackawanna, the Baltimore and Ohio, the Atlantic Coast Line, the Reading, and Jersey Central.

REINFORCED CONCRETE COALING STATION

SOUTHERN RAILWAY.

Following out the recent engineering practice of utilizing reinforced concrete in large structures, there are at the present time a number of coaling stations in service in different parts of the country constructed in this manner. The service obtained from all of these has been very satisfactory and seems to indicate that this form of construction is particularly well adapted to structures of this kind located at railroad termi- bodies the feature of weighing the coal before it is delivered to the locomotive, which has lately come into extensive use on the Santa Fe lines.* Coal is delivered to the locomotives on two tracks, each of which is served by two 10 ton weighing hoppers supported on Fairbanks platform scales, as shown. In this particular station the entire pockets, as well as the scale beams, are built of reinforced concrete.



ELEVATION OF REINFORCED CONCRETE COALING STATION—SOUTHERN RAILWAY.

nals where they are almost continuously exposed to the smoke and gases so destructive to steel.

It is easy to see that the depreciation on the structure itself where concrete is used is very small and in most cases can be neglected, resulting in no expense whatever for maintenance, while with wood or steel construction or a combination of the two, the maintenance charge is large, as is also the depreciation.

An example of this type of coaling station, located at Asheville, N. C., is shown in the illustrations. A structure of this kind not only presents a very pleasing appearance, but it has the additional advantage of being fireproof, a very important consideration for buildings at railroad terminals.

This station was erected for the Southern Railway Co. and is of the mechanical type with 1,000 tons capacity. It also em-

The foundation for the structure consists of solid concrete piers extending 13 ft. below the top of the rail of the coaling track and resting on wood piling driven to solid rock. Reinforced concrete is used throughout the remainder of the structure in every possible place. The main coal storage pocket without the scale pockets has a capacity of 960 net tons, and the four scale pockets have a capacity of 10 tons each.

Coal is delivered from the main overhead pocket to the scale pockets by gravity, the flow being controlled by under cut gates in the hoppered floor of the former. The scale pockets are provided with drop gates and steel aprons for delivering the fuel to the two tracks running underneath the building.

There is an overhead wet sand storage pocket in the same

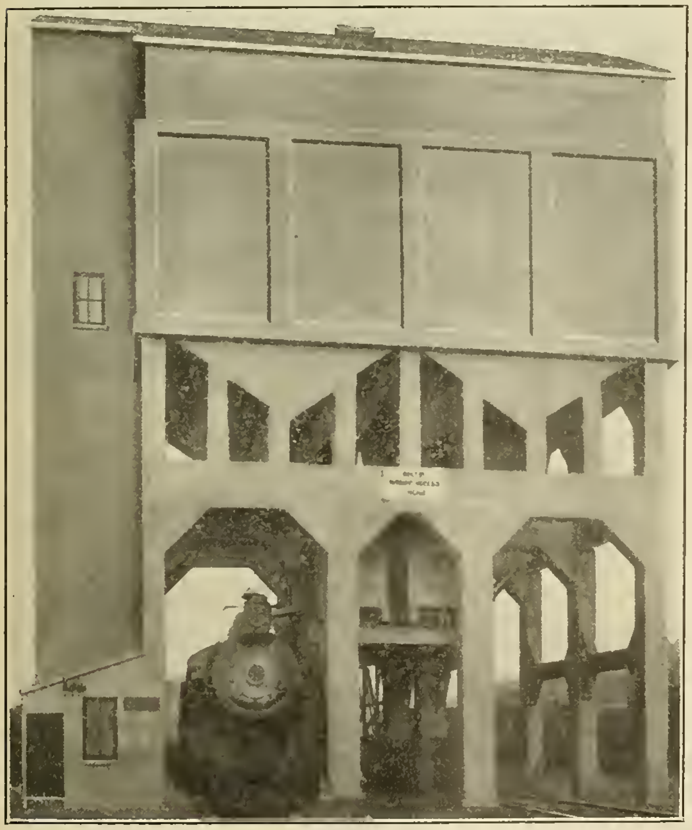
* See American Engineer, May, 1910, p. 161.

structure with a capacity of 100 net tons. In connection with this the compressor room, sand drying room, elevator housing, machinery supports and roof are constructed of reinforced concrete.

The concrete for the main structure above the foundation consists of one part Portland cement, two parts granite screenings, and four parts of broken stone; while that used in the foundation consists of one part cement, three parts sand, and five parts broken stone. The reinforcing throughout consists of Johnson's corrugated steel bars.

COAL HANDLING MACHINERY.

Coal is delivered to a 15 by 20 ft. receiving hopper located underneath the receiving track and is carried to the elevator by an automatic loader, which insures the proper amount of coal being delivered to each bucket of the elevator, The elevator and conveyor, which carries it up and distributes it to the overhead pocket, consists of "V" shaped buckets mounted on a steel roller chain and has a capacity of 100 net tons per hour. The power for driving the elevator is supplied by a 30 h. p. alternating current motor located above the main pocket and connected to the driving shaft by a leather belt.



A SOLID CONCRETE COALING STATION.

SAND HANDLING MACHINERY.

Wet sand is shoveled into a small receiving hopper located on the outside wall on a level with the top of an ordinary gondola car, and then elevated to the wet sand storage pocket by a centrifugal discharge elevator, consisting of a rubber belt with small malleable iron buckets. The capacity of the elevator is 10 tons per hour.

The sand drying room is directly under the wet sand pocket, so that the sand is delivered by gravity to a steam dryer in the drying room. After being dried and screened, it is delivered to a sand drum, also located in the same room, from which it is finally elevated through a four inch pipe to the overhead dry sand storage bin by means of compressed air.

A small compressor connected by a belt to a 5 h. p. motor, both of which are located in a separate house on the ground level, supplies the compressed air for this elevating scheme. The dry sand bin is equipped with two sets of outlet fixtures and spouts so that locomotives on either of the coaling tracks may be supplied.

The entire coaling station, including foundations and equipment, was designed and erected by Fairbanks, Morse & Co., all the machinery and appliances being products of their factory. The station has been in successful operation since January, 1907.

WHY MANUFACTURERS DISLIKE COLLEGE GRADUATES.*

The central idea that the boy gets at college is training, training of the mind, storing the mind full of things. Now I say, without the slightest hesitation, that for success in life, intellectual training comes second or third. Without the slightest question, character comes first; good sense, second, and intellectual training third. The entire emphasis of the college life is on intellectual training. As long as the man commits no offense which sends him to jail, it is very little of the business of the management of those universities what those boys do.

What is the remedy for these faults? I do not believe there is any panacea for all faults, but I do believe that there is a great palliative possible. I believe that every young student in our colleges, from the student who intends to be a minister, on the one hand, to the mechanical engineer, on the other hand, should leave college at the end of the freshman year and spend at least one year in actual hard work in a shop of some kind. I say shop, because he will be certain to be under careful and constant supervision when working in a shop as a workman, alongside workmen.

I would not send them there with the idea of getting intellectual training. If they do, it is a mere incident. I would send them there mainly for the purpose of giving them a real look at life's work and give it to them early enough so as to affect the last three or four years of their college life. When they start work in a shop, under good rigid discipline, they then begin to get the character training, which is almost entirely lacking at college. They then begin to learn the great lesson of life, that almost nine-tenths of the work that every man has to do is monotonous, tiresome and uninteresting. Then they start to develop the character which enables them to do unpleasant, disagreeable things. This is the greatest training, to my mind, which they get in the shop. They learn that life is made up mainly of serving other people, not that the world is there to teach them something new. I think that almost invariably they start into the shop with the common idea, "Now I am here to learn something, to get something in this shop that is going to be a fine engineering education for me." They fail at once, for there is no great intellectual training in the shop. Many of them cannot stand the monotony and fail to get the real character training that comes from that work.

* Extract from the discussion of Frederick W. Taylor before the Society for the Promotion of Industrial Education.

LOCOMOTIVE TESTING PLANT, UNIVERSITY OF ILLINOIS.—Upon the recommendation of Robert Quayle, Superintendent of Motive Power and Machinery, the locomotive testing plant of the Chicago & North-Western Ry. has been presented to the University of Illinois. It is understood that the plant will be held by the university pending the construction of its proposed transportation laboratory. The testing plant was designed under the general direction of Mr. Quayle, aided by E. M. Herr. The drawings were developed under the immediate direction of E. B. Thompson, now Supt. M. P. and M. of the C., St. P., M. & O., but who at that time was chief draftsman for the C. & N. W. The proceedings of the Master Car Builders' Association will show that this plant was an important factor in the development of several committee reports dealing with the design of exhaust pipes, steam passages, draft pipes and stacks. It is announced by Dean Goss, of the College of Engineering, that the plant at the university will constitute a portion of the equipment of the School of Railway Engineering and Administration, and that when installed it will be operated under the immediate direction of Professor Edward C. Schmidt.

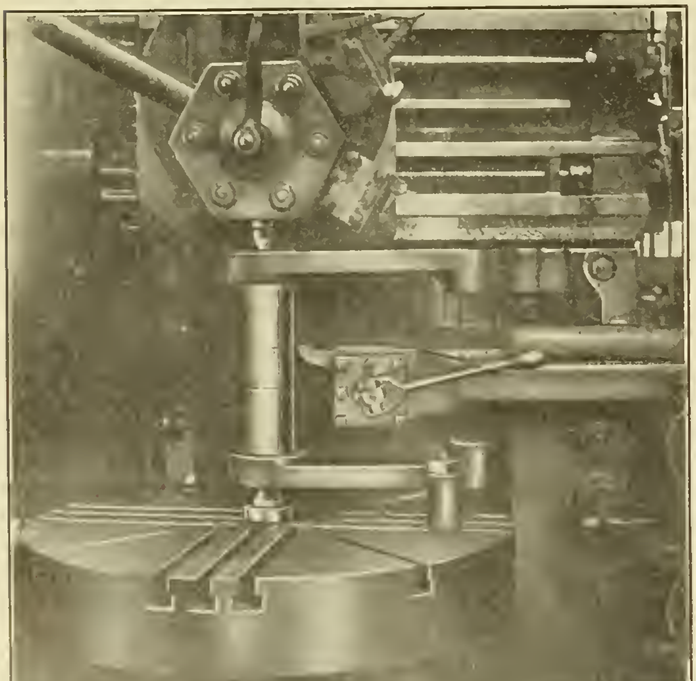
MACHINING A LOCOMOTIVE ROCKER SHAFT

CHAS. D. CHANDLER.

The accompanying illustrations are taken from a modern and recently equipped Western railroad shop in which the variety and adaptability of the machine tools are considered quite complete for any and all lines of work relative to the repair and maintenance of the class and style of power in use.

There are in service on this railroad a number of Walschaert valve gear engines using rocker shafts with arms extending in the same direction and also with inward projecting bosses and fork ends. In the natural course of service and wear it was found necessary to "true up" the shaft bearings, for which operation it was discovered that no engine lathe in the shop had the proper swing and a sufficiently narrow tool rest and cross-slide to permit of any travel of the carriage between the revolving arms. The marked success with which this was eventually accomplished is well shown by the pictures of the different styles of shafts mounted on centers and being machined in a vertical turret lathe. The merits of the lathe feature of this arrangement are quite decidedly evident in this case by using one of the turret face holes for a center virtually conforming to the ordinary engine lathe tail stock, the other center being in the table or face plate which corresponds to the head-stock to which are also secured the bolts for driving the shaft around.

If the reader will now turn the bottom of the picture to the left hand, the similarity to all lathe conditions will be quite apparent. With the shaft accurately and securely centered, the narrow side head is then most advantageously brought into use, with relatively the same effect as that of the ordinary lathe carriage and tool post. The shaft is relieved undersize just in the center, thus leaving a bearing portion about 4 or 5 inches long

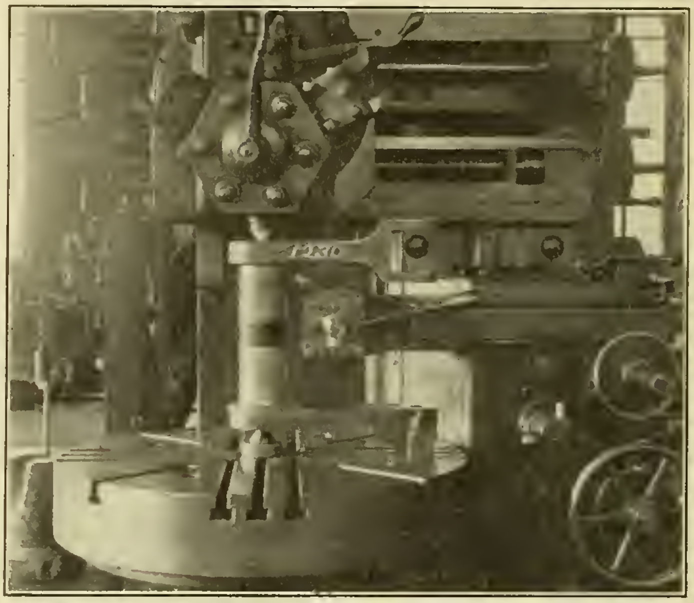


MACHINING ROCKER ARM ON BULLARD VERTICAL TURRET LATHE.

to be trued up, which can be turned full length with one tool setting by using the narrow side head.

The boxlike section and liberal bearings of the side head make this a very rigid operation, favorable also to which are the short heavy centers just permitting the arms to pass under the crossrail.

While the above is submitted as somewhat of a novelty, it strongly emphasizes the increasing utility of the modern tool



ANY TYPE OF ROCKER CAN BE MACHINED WITH EQUAL FACILITY.

and its possibilities when local conditions are given a little study and careful attention. The machine on which the above was accomplished is a 36-inch vertical turret lathe built by The Bullard Machine Tool Co.

RECORD FOR REPAIRING LOCOMOTIVES.

The Sayre shops of the Lehigh Valley Railroad are said to have established a new record for repairing locomotives. This record covers a period of seven months from September 30, 1909, to May 1, 1910, during which time one repaired locomotive was turned out every 3½ working hours. The force of employees at this shop includes 1,000 men in the locomotive department, 450 in the freight car department, and 150 on passenger cars. The work done in the locomotive department during the period mentioned is given in the following table:

Month.	Rebuilt.	New Fireboxes.	Back Flue-Sheet.	Engines, Total.	Hours Worked.	Hrs. Worked Per Engine Repaired.
Oct., 1909....	..	5	6	50	168	3.4
Nov., "	1	4	5	47	152	3.2
Dec., "	1	4	5	52	184	3.5
Jan., 1910....	1	6	5	53	168	3.2
Feb., "	1	3	6	41	153	3.7
Mar., "	1	4	8	47	198	4.2
Apr., "	2	6	11	61	212	3.3
Total	7	32	46	351	1,235	3.5

Power Consumed by Machine Tools.—A graphic recording wattmeter in circuit with the motor on a tool not only tells the actual power consumed by the machine, but also shows whether the tool is operating at its maximum rate, by registering the time of unproductive cycles or the length of time the tool is idle; and by analysis, the cause of the lost time may be discovered and result in a change of conditions with a corresponding increase in production. Poor lineshaft alignments have been detected by watching the integrating wattmeter. Many shops are paying dearly for lack of attention to alignment of shafts, etc.—*Chas Fair before A. S. M. E. and A. I. E. E.*

DRIVING BOX WITH REMOVABLE BRASS.

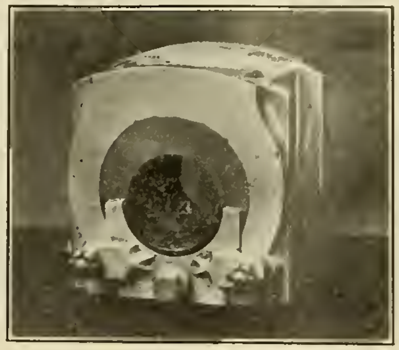
A design of driving box with removable brass and arranged for carrying a large amount of grease in a cavity above and around the brass, has been in use on the Wabash Railroad for over a year, giving results that are in every way satisfactory. It was designed and has been patented by L. K. Smith, assistant master mechanic at Moberly, Mo.

The removable brass has a flange on the inside which sets in a recess in the box and is slightly tapered toward the outside on the lower faces. It is held in place by the heavy cellar which

DRIVING BOX WITH REMOVABLE BRASS DISMANTLED.

is dovetailed into the box at the bottom and bears against the tapered face of the brass at the top. This cellar is drawn up and held in place by two studs on the inside of the box. The lugs on the cellar and arrangement of the studs are clearly shown in the illustration. When the cellar is drawn into place the brass is securely held and has a bearing on the box on all its upper surface except where the latter is cored out for the grease cavity. There are no studs or other fastening for securing the brass in place and it is easily possible for one man to remove and replace a brass under a locomotive in one hour.

An original scheme is employed for a lubrication reservoir of



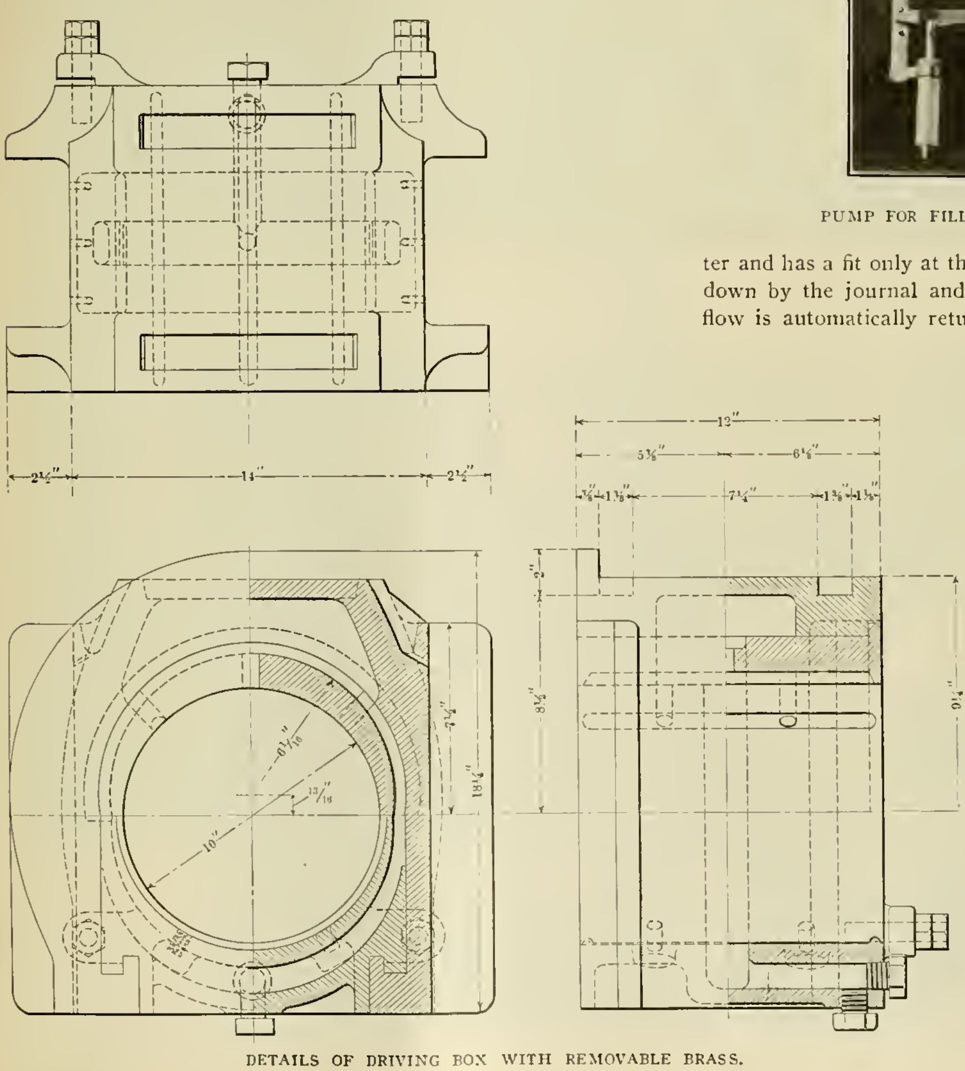
DRIVING BOX WITH REMOVABLE BRASS ASSEMBLED.

capacity sufficient to last from one shoping to the next under ordinary circumstances. This consists mainly of a large cavity in the box above and around the brass which is filled with grease as will be explained later. The brass is provided with grooves in the usual manner and openings from each communicate with the reservoir. Under the journal there is a corrugated steel sheet held up against the axle by two small coiled springs seated in the cellar. This plate stands away from the journal at the cen-

PUMP FOR FILLING RESERVOIR WITH GREASE.

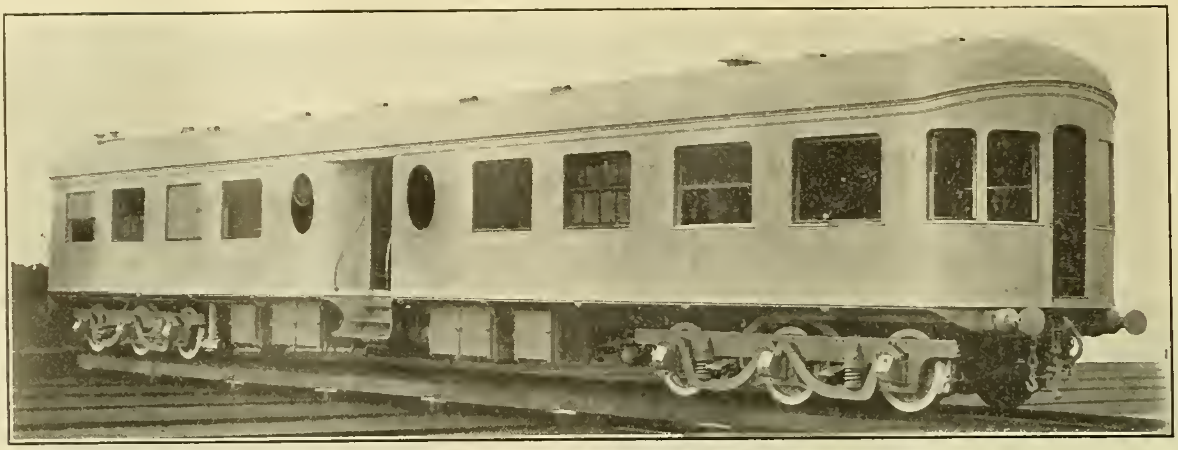
ter and has a fit only at the ends. It catches the lubricant brought down by the journal and is soon filled with grease. Any over flow is automatically returned to the reservoir through passages provided for that purpose.

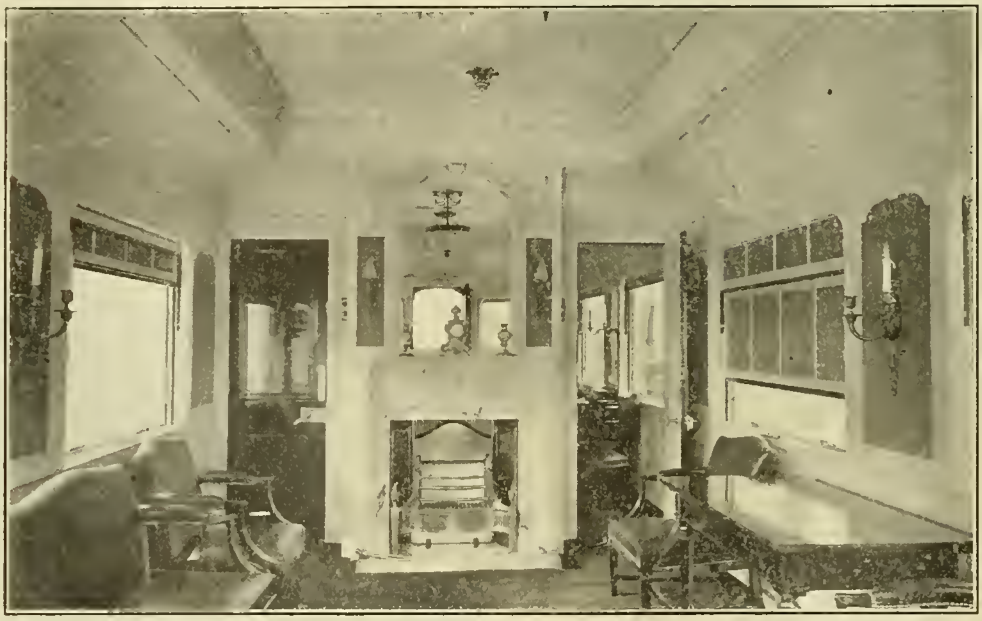
The packing of driving box with grease is a very simple matter. Either of the plugs, one under the cellar and one on the side of the cellar, is removed and the device, especially designed for packing the box, is applied, the operator filling the pump with grease cartridges 1 inch in diameter and about 4 inches long, each cartridge weighing 2 ounces. This is forced into the box until the cavities are filled. The grease, after entering the cellar, is forced up through the cavities in the cellar and brass, to the main reservoir. The grease is fed to the journal automatically by expansion, when the engine is in motion.

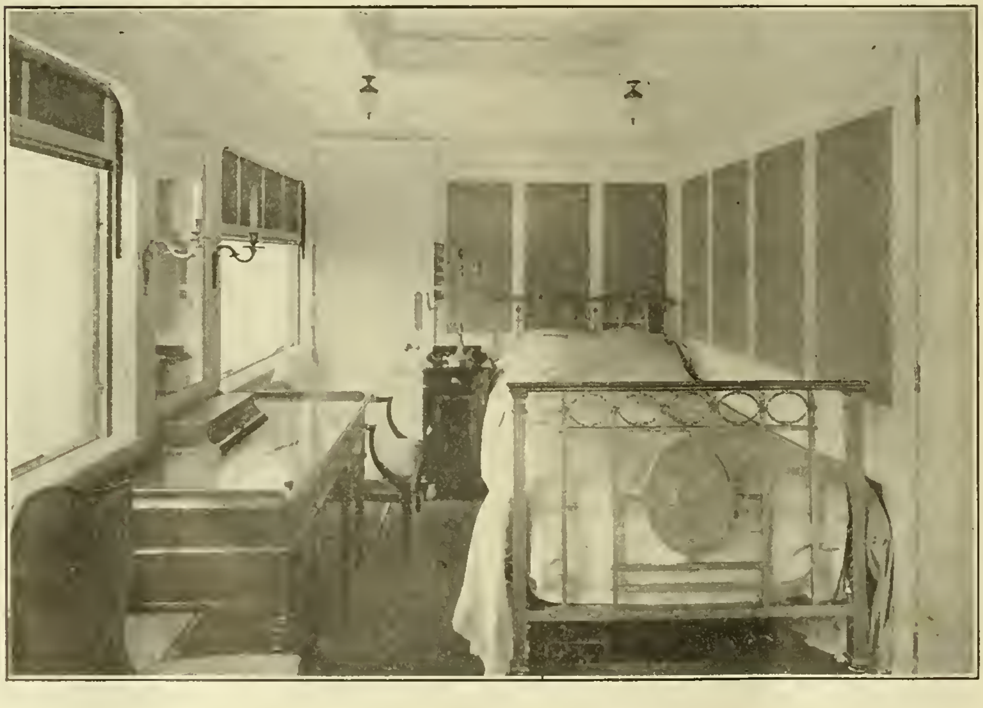


DETAILS OF DRIVING BOX WITH REMOVABLE BRASS.

It is reported that the Santa Fe intends to convert all passenger locomotives running between Kansas City, Mo., and Newton, Kan., to oil burners.







EXTERIOR AND INTERIOR VIEWS OF A PRIVATE CAR BUILT FOR THE PRESIDENT OF THE ARGENTINE REPUBLIC.

PRIVATE CAR FOR SOUTH AMERICA.

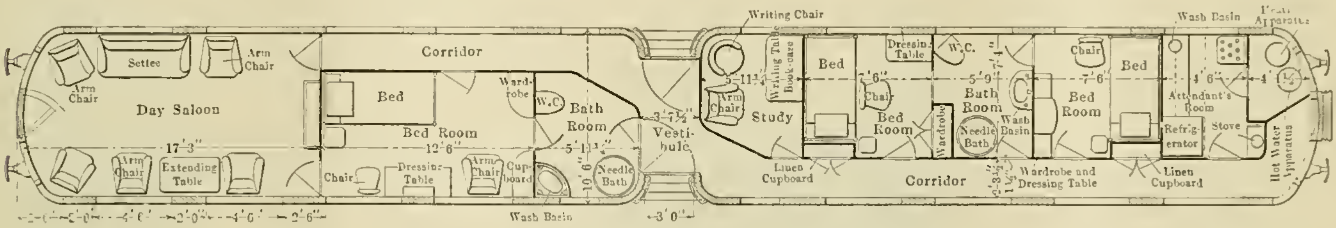
An unusually luxurious private car has recently been delivered to the President of the Argentine Republic by the Metropolitan Amalgamated Railway Carriage and Wagon Co., of Birmingham, England. This car will be exhibited at the Buenos Ayres centennial exposition.

In several particulars novelties of design have been incorporated in this structure that improve its general appearance and also increase the available space. This is particularly noticeable in the case of the entrances, which are in the center, the doors being set back about 18 in. from the outside faces of the car, the sides of the body being curved in to meet them, while the roof is taken straight through and forms a canopy over the steps. Another attractive feature is the rounding of the ends and the location of the windows on the corners, permitting an exceptionally broad view from the observation room.

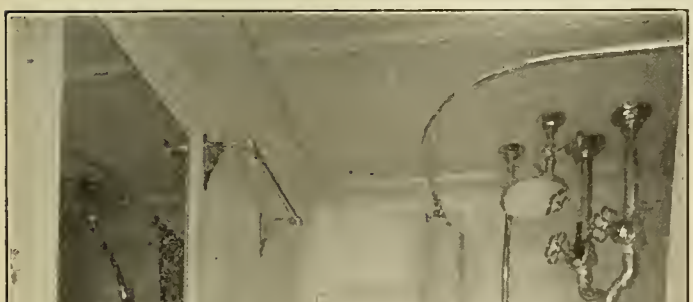
Since the car does not include dining facilities an opportunity has been given to provide unusual space for sleeping rooms and bathrooms. The floor plan shows the general arrangement clearly and well illustrates the exceptional facilities afforded. This is particularly noticeable in the president's bedroom, which measures 7 ft. 3 in. by 12 ft. 6 in. and is adjoined by a 6 by 7 ft. bathroom. The car measures 76 ft. 6 in. over end sills and has a width of 10 ft. 6 in. It is carried on two 6-wheel steel trucks, special care being given to the easy riding qualities.

It is really to the interior and exterior finish that special attention is drawn, and in these particulars it excels anything that has ever been on exhibition. Beginning with the observation room, which is finished in hand carved mahogany, painted white and paneled with green silk and includes a fireplace with a marble hearth and fittings. the same elegance is carried throughout the whole car. In this section the furniture is of the best Spanish mahogany upholstered in dark green leather and the floor is covered with thick green pile carpet. One of the illustrations shows part of the interior of this room and in another is shown the president's bedroom and bathroom. In all of these the artistic electric light fixtures and the particularly pleasing arrangement of the ceilings are evident. In the bedroom the panels and carpet are of a deep blue. In the bathroom the walls and doors are paneled up to the window sills in marble and the fixtures are nickel throughout. The remainder of the car is finished in a similar manner, the study being finished in red.

On the exterior, the car is sheathed with steel and painted an ivory white, decorated in blue and gold. The window frames are of brass, which is polished and the underframes and trucks are painted in a light gray. The car carries two axle generators, large water tanks, etc.



PLAN OF CAR SHOWING ARRANGEMENT OF QUARTERS.



PRESIDENT'S BATHROOM IN PRIVATE CAR.

LOCOMOTIVE CRANE IN STOREHOUSE YARD.

A most useful piece of machinery is a locomotive crane, which can be used for many purposes.

First, in unloading piling and lumber from open cars. I find it costs $6 per car to handle by hand where cars must be moved by hand back and forth to properly assort them on ways of their respective lengths. This same work can be done with a crane for $1.40 per car, or a saving of $4.60.

Car and engine bolsters cost to handle by hand $5 per carload of seventy-five; these can be handled by locomotive crane for 75 cents, or a saving of $4.25.

One hundred 4¼ x 8 axles—by hand $5.50, by crane $1.50, saving of $4. Mounted wheels to axles—by hand 75 cents per car, by crane 17 cents, saving 58 cents. These are only a few instances for which the crane can be used, but it is not necessary for me to enumerate further.

I also find in handling scrap that the cost by hand for an average of 100 cars is $7 per car; with the crane it is $2.83, or a difference of $4.37 in favor of the latter.

The same saving can be accomplished in loading piling and heavy lumber.—*J. F. Slaughter at the Storekeepers' Convention.*

RAPID CONCRETE WORK.—Working on the concrete foundations of the new locomotive shop of the Boston & Maine Railroad at Sommerville, Mass., the Aberthaw Construction Co. installed about 2,000 yards of concrete at a total cost of $1.36 per cu. yd. This low cost on a job of this size was possible because of the erection of a complete construction plant for the work, although it was in operation only about five weeks.

COALING WITH LOCOMOTIVE CRANES

In 1905 the Grand Rapids & Indiana Ry. started the use of locomotive cranes for handling fuel at some of its coaling stations. The experience since that time has been entirely satisfactory and such as to indicate this to be the most efficient system for stations handling from 300 to 400 tons a day.

A 600-ton pit is provided at these stations into which the coal from hopper cars is emptied. Other types of cars are emptied by the bucket direct. From either these cars or the storage pit, the fuel is transferred by the crane to either the tender or to a series of elevated 5-ton hoppers seen on the left in one of the illustrations. From these hoppers locomotives can be coaled at any time without delay or at times when the crane is engaged in handling cinders.

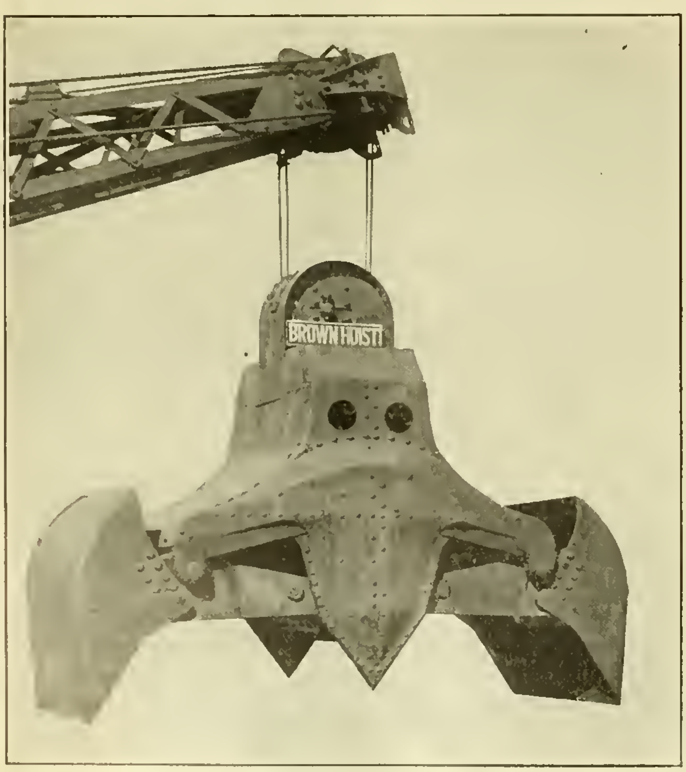
This arrangement eliminates many of the objections mentioned in the discussion of locomotive cranes for this service in the series of articles on Locomotive Terminals which appeared in the January, February and March issues of this journal. These briefly were: Use of cars for storage, damage to car equipment and delay to locomotives in taking coal. In this case, there is no damage possible to the hopper cars which of course form a large proportion of the supply, and no serious delay to any cars unless an unusual number of closed bottom cars arrive at one time.

Two men form the entire force at these stations, one is the crane operator and the other a helper whose duties consist largely of shoveling coal from ends and corners of cars, keeping the grounds clean, etc.

At one station a contract is made with the operator to handle all coal from cars or pit to locomotive tender for 3½ cents a ton. At the Grand Rapids station during the month of March, 1910, there were 6,506 tons of coal handled at an average cost, including repairs and supplies, of 4.8 cents per ton on the tender. The repairs and supplies amounted to but .8 cents per ton.

Brownhoist 10-ton cranes are used at these stations, being equipped with 54 cu. ft. two rope, grab buckets. These cranes are arranged for very high speed in operation and are especially suited for this work. They have 35 ft. booms and a radius of from 15 to 35 ft. One of the illustrations shows the bucket at close range. This type of bucket has been found to be particularly adapted for cleaning cars and can be hung either lengthwise or crosswise of the boom as desired by the operator.

LOCOMOTIVE CRANE FILLING ELEVATED COAL HOPPERS.



TYPE OF GRAB BUCKET USED ON LOCOMOTIVE CRANE.

HOT-WIRE SYSTEM FOR TUNGSTEN LAMPS

An ingenious scheme to overcome the brittleness of the tungsten lamp filament when not burning was devised by E. M. Fitz, Electrical Eng'r. of the Pennsylvania Lines West of Pittsburgh, in which he arranges to have a small current passing through the lamp when extinguished, which has been used by his road with great success. On cars using 63 volts (32 cells) the two end cells of the battery, giving 4 volts, are connected to the lamps when extinguished, which keeps the filaments at a faint dull red and makes them about as rugged as a carbon lamp. The lamps when lighted are connected to the remaining 30 cells, 60 volt lamps (instead of 63) being used. This scheme is known as the "Hot-Wire System," and is being patented. Recent figures show lamp lives of from 1,500 to 2,000 hours by this system.

In practice it is found that the two end cells of the battery are no more exhausted than are the remaining cells, as one would at first suppose. This might occur, however, if the burning hours were very short, the lamps being connected most of the time to the two end cells. On account of the lesser current taken from the end cells it is estimated that the lamps should burn an average of about three or four hours out of the 24 to have all the cells exhausted to the same extent.—*From "Train Lighting by Electricity" by Henry Schroeder—Proceedings of the Richmond Railroad Club.*

EFFICIENCY TESTS.—Over 300,000 efficiency tests were held last year by the Pennsylvania Railroad, resulting in the practically perfect record of all employees. The average number of tests each day was 820, and of the total for the year 99.75 per cent. were perfect. Many of the failures, however, were not such as could possibly cause an accident to the train.

HANDLING ENGINES*

H. H. VAUGHAN.

The desirability of pooling engines in place of operating them by regularly assigned crews depends, in the writer's opinion, on whether the engines are engaged in passenger or freight service, and in the latter case, on the conditions which exist.

PASSENGER SERVICE.

Where traffic conditions admit of the engine making greater mileage than can properly be run by one crew, two crews assigned to one engine, or three crews to two engines, will enable the engine to make as great a mileage as is desirable. On account of the comparatively short time occupied from terminal to terminal, the crews can usually make a round trip without holding the engine longer than is required to handle it and prepare it for the return trip or to await its train. By using more than one crew to the engine, it is theoretically available on its return just as soon as though it were pooled. In practice, unless pooling is carried to the extent of sending out any engine on any train, certain engines are regularly used on certain trains or groups of trains, and it is comparatively easy to arrange the crews and engines so that a reasonable time may be allowed for repairs and yet ample service be obtained from the engine. When working with assigned crews it is of course usual to employ some extra passenger men to take the place of the regular men, who are also available in case an extra trip is required from an engine on account of specials or extra sections of regular trains. Where regular scheduled trains have to be provided for, this system is as flexible and convenient as pooling and has the additional advantage in passenger service that the men run certain trains regularly, and will consequently give better service than when handling a number of trains indiscriminately.

Pooling in passenger service probably does not require much discussion. The system is not in extensive use and will presumably have few advocates. The writer would, however, state as a result of his experience with both pooled and assigned engines in passenger service, that he is most strongly opposed to pooling in this service and considers that far better results can be obtained from assigned crews.

FREIGHT SERVICE.

Here conditions are very different. The time is slow and a long time is occupied from terminal to terminal, so that crews may require a full allowance of rest on arrival, or may even have to be relieved on the road. Few, if any, of the trains run at regular hours, and in place of following a defined schedule, the demand for engines varies with the traffic. When business is heavy, engines are wanted as soon as they are repaired and ready for service, making it difficult, if not impossible, to select the engines in any particular order. By pooling, such difficulties may be more easily met, especially at large terminals. When engines are assigned the practice usually required by the agreement with the men is that engines shall be prepared and despatched in the order in which they arrive, but if the engine is ready its use may be retarded by the time required by the crew for rest. In pooling, both these objectionable conditions vanish. An engine may be turned at once if fit for service and thus rendered immediately available, and the movement of the men being entirely independent of that of the engines, the detention of engines at a terminal can be regulated by simply increasing or decreasing the number in the pool.

Under such conditions, if pooling is not carried on in name, it will be in fact, simply because business cannot be handled unless engines are used without reference to the order of their arrival. Granted therefore that pooling is advantageous under these conditions, it should be done properly. All the features necessary to a successful pooling system must be employed, such as thorough terminal inspection independent of the engine crews, and arrangements for handling tools and engine supplies, and caring for headlights, oil cups, etc. If pooling is resorted to when business is especially heavy, or when traffic is disturbed by storms or by other causes, without proper arrangements being made, the results are most objectionable. Under these circumstances, the condition of the power will depreciate rapidly and the service rendered will be excedingly inefficient. The maxim is frequently stated, "If you pool, pool," and its wisdom has been demonstrated by experience. The real question about pooling is therefore whether there are conditions under which it is preferable to adopt the alternative practice, that of running engines with assigned crews. This depends on the results obtained from the two systems, which are in the writer's experience as follows:

Mileage.—It is possible to obtain somewhat greater average mileage per engine under the pooling system, but the increase does not exceed ten per cent. when traffic is being handled smoothly and without excessive congestion and delays.

Repairs.—When running successfully under the assigned engine system, repairs are less than when similar conditions exist with pooled engines. A man running an engine regularly keeps up the smaller details and knows what work is required at once, and what must be looked after in due time. His inspection reports are more reliable than those of a man who has had an engine for one trip only. As he has to run the engine next trip as well, he will handle it with greater care and avoid any action that will cause him trouble in the future. Men who have been accustomed to running pooled engines will not do all this at once, but they most certainly will if assigned to an engine for any length of time, and the difference is noticeable in engine houses where some engines are assigned and some are pooled.

Engines are sometimes taken care of by the headquarters station system, the work required to maintain the engine in proper condition being done at the terminal designated as the home station, while at the other terminal the only work done is that necessary for the return trip. With this arrangement, even with pooled engines, the same crew will, if possible, make the round trip; but when they are changed, practically as much work is required at the away station as at the home station. The result is a considerable increase in the cost of repairs, for there is not as a rule very much difference in the cost at the home station.

When the assigned engine system proves inadequate for traffic demands, the results change. Men will endeavor to book enough work against the engine to hold it until they have rested, and on the other hand engines are liable to be wanted before repairs that are actually required are completed. Under these conditions engines may be better and more cheaply maintained when pooled; but under normal conditions the writer's experience would show that with assigned crews the cost of running repairs may be reduced five to ten per cent. and better mileage obtained from the engines between shoppings.

Fuel.—It is almost impossible to determine the fuel consumed by an engine on an individual trip, and consequently difficult when pooling to keep any record of the amount of coal used by different men. A record may be kept by engines, but it is then impossible to locate the responsibility for any excessive consumption. The practical result is that on pooled engines, individual fuel records are of comparatively little use. With assigned engines, while trip records may not be individually accurate, the average of several consecutive trips soon becomes so, as the variation of the amount of coal left on the tender, while important on one, is of comparatively small importance on a number of trips. There is no doubt in the writer's mind that individual coal records, whether by trip or by period, are an

* Presented before the joint meeting of the A. S. M. E. and I. M. E. at Birmingham, England, July 26, 1910.

important factor in obtaining economical results in fuel consumption, both from men and from engines, and he ascribes the good results that have been obtained on the Canadian Pacific Railway largely to the careful way in which the records have been watched.

Apart from the records, the familiarity of the men with the engines has an important bearing on fuel consumption. Most engines vary slightly in the way they burn the coal, in the nature and intensity of the draft, and in the best position for the throttle and reversing lever. Crews knowing an engine thoroughly learn about these peculiarities, while they do not when running a different engine each trip. One crew will obtain from an engine results that are impossible for another crew, and thus the result with assigned crews is a tendency to higher efficiency than when every engine has to be drafted and adapted to do the work with the poorest crew on the division. It is only necessary to watch the difference in the way an engine is handled by a regular crew and by a pooled crew, to realize the advantage of the former, and important results have been clearly shown with the same men and engines, on divisions where the two systems have been in effect.

Service.—The remarks that have been made in connection with repairs and fuel apply with almost equal force to the class of service obtained from the engines, with reference to failures, breakdowns and ability to make the time required. A crew that knows the engine will get more out of it than one that does not. They will notice any difference in its working and will take more interest in getting any defect rectified. They will keep their equipment in better condition and will pay more attention to bearings which show signs of heating, etc. All these conditions lead to better and more efficient service.

Engine House Expenses.—Inspection, the care of tools, the filling of lubricators, headlights and cab lamps, are commonly looked after on assigned engines by the crews. When engines are pooled this work has to be done by the engine house force. At a large terminal this expense is not large, but when the number of engines handled is small, it is difficult to arrange the duties of the men doing this work to prevent its becoming a serious item. Conditions vary on different roads in this respect, but the fact remains that this work is not in any way burdensome to men having a regular engine, while it is burdensome if they are required to prepare a different engine each trip, and consequently they object to it very strongly. In the majority of cases this work constitutes an additional charge on engines that are pooled.

CONCLUSION.

In conclusion, the writer considers that in passenger service pooling is objectionable under any conditions and should be avoided if possible.

In freight service, pooling is advisable if conditions are such that engines cannot be run with assigned crews, and probably on divisions where business is so heavy that sixty engines per day or over are despatched from the terminal; but the writer's experience is that where assigned crews can be used on engines, the cost of repairs, the amount of fuel consumed, and the class of service obtained, will all be more satisfactory.

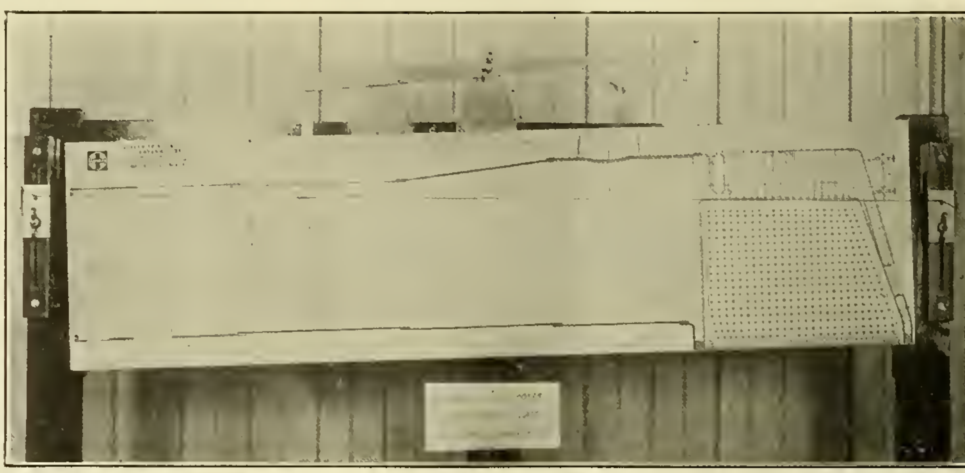
He therefore regards pooling as a practice that may be necessary under certain conditions, but that is certainly not desirable if the alternative system can be satisfactorily carried out.

DEMONSTRATING MODEL TO SHOW EFFECT OF GRADES ON WATER LEVEL.

For the purpose of instructing engineers as to the effect on the water level in the boiler of ascending or descending steep grades, a very ingenious model has been originated on the Atchison, Topeka and Santa Fe Railway. These models will be distributed at the various division points where the road foremen will give demonstrations to the engineers, who will also be encouraged to use it themselves whenever they desire.

MODEL SHOWING LOCOMOTIVE ON LEVEL TRACK, ONE GAUGE OF WATER.

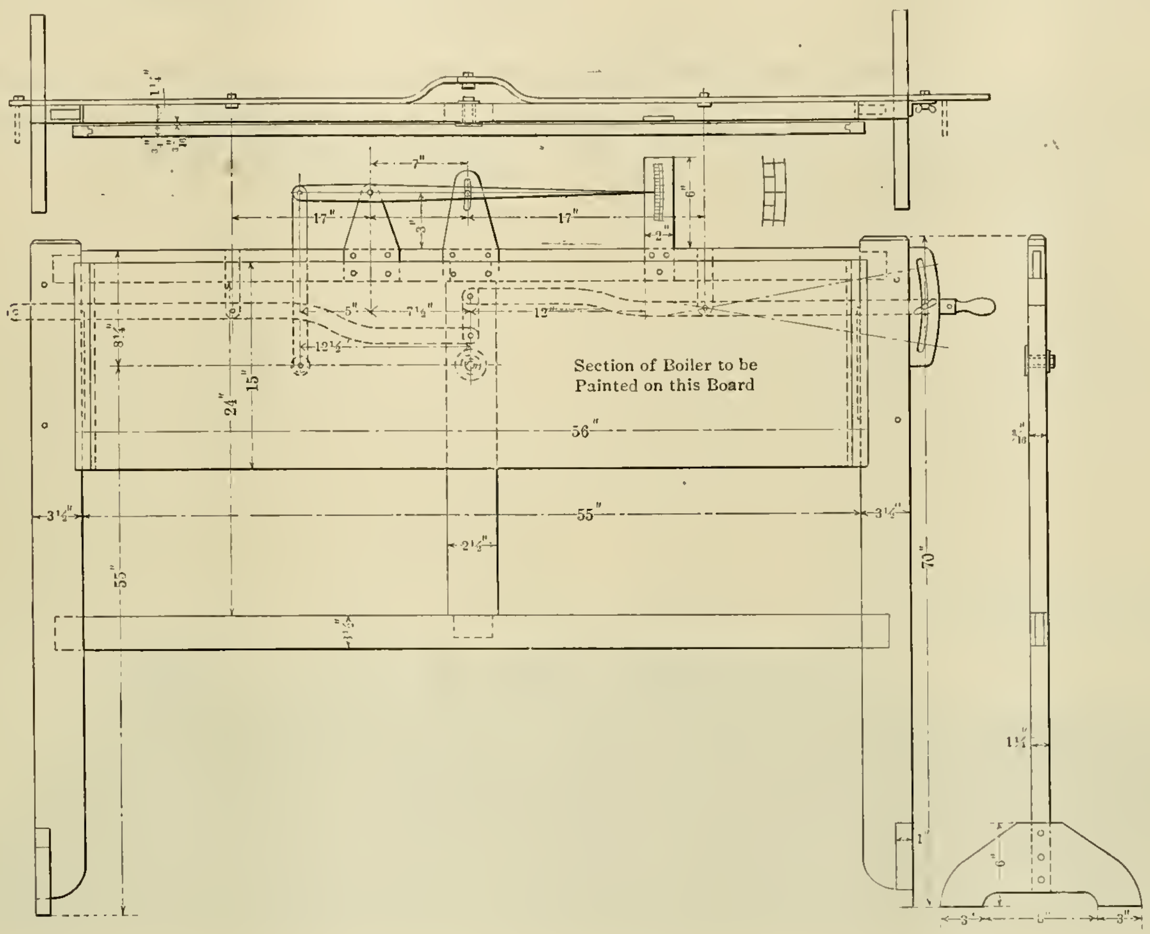
The model includes a frame supported at its center of gravity in such a manner that it may be swung to various positions and secured in any desired position. This frame carries a blue print showing the section of a locomotive boiler. Several different frames have been provided, each frame carrying a different boiler, a sufficient number being included to cover the principal classes of locomotives on the system.



SHOWING EFFECT OF 3.5 PER CENT. GRADE ON THE WATER LEVEL OF A BOILER WITH ONE GAUGE ON THE LEVEL.

Attached to the swinging frame is an indicator arrangement, the pointer traversing a scale which shows the grade that a locomotive would be ascending when the boiler model is adjusted at a certain angle. This is arranged to show a grade from zero to four per cent. Inasmuch as there are a number of heavy grades on several sections of the Santa Fe system, and while 2½ per cent. is by no means uncommon, there are several grades over 3 per cent., and some 3½ per cent., the limit of 4 per cent. shown on the model is not unreasonable.

The frame carrying the blue print, as well as the indicating mechanism, is supported by a wooden frame that permits it to be moved as desired and locates it at a convenient height. This frame also carries an adjustable mechanism holding a wire representing the water level which stretches across in front of the boiler chart. The mechanism (the photographs show an earlier arrangement) which carries this wire is so constructed that it will be level at all times and permits it to be readily adjusted at any height above the crown sheet or at any gauge of water.



DETAILS OF MODEL FOR DEMONSTRATING THE EFFECT OF GRADES ON THE WATER LEVEL.

One of the illustrations shows the boiler on a level track, or zero per cent. grade, with one gauge of water in the boiler. On this the depth of water at any point can be readily seen and measured. Another photograph shows the locomotive descending a 3½ per cent. grade and the level of the water which showed one gauge when locomotive was on the level. The bare crown sheet resulting is very strikingly illustrated. The effect when ascending the same grade or of going up or down any grade can, of course, be shown equally well.

This model was originated by W. F. Buck, Superintendent of Motive Power, and the details were designed and the models constructed under the supervision of M. H. Haig, mechanical engineer at Topeka. A patent has been applied for covering the idea and the construction.

COPPER VS. STEEL FOR LOCOMOTIVE FIREBOXES.

In a paper on this subject read by H. B. Lake, chemist to the Western Pacific Railway, before the Western Canada Railway Club, the author stated that sheet copper weighs one-eighth more than sheet steel. Assuming the price of steel at 3 cents and copper at 21 cents, then copper costs seven times as much as steel, and as the thickness of the sheets of copper used in a fire-box is generally about twice that for steel, the initial cost of the material for the copper box will be a maximum of sixteen times that for a steel box. Allowance, however, has to be made for the value of the scrap copper, which locally was stated to be 75 per cent., and allowing 5 per cent. of this for the steel scrap, this reduces the ratio of the cost of the copper plate to about five times that of the steel. As regards the labor cost of making the box, this is in favor of copper. Being the easier metal to work, it induces less wear and tear on tools, and in addition the time required to make the copper box is less. Where cost of labor bears a high ratio to cost of material then this factor will increase in importance.

The possible life of the two fire-boxes depends largely on local conditions. The life of copper boxes on English roads is about ten years, or the equivalent of about 800,000 miles, and copper tube plates last about five years in hard, constant service at high pressure. Steel boxes, under similar conditions, gave a life of only one year, or about 80,000 miles, before requiring repair, and on a certain section of the Canadian Pacific Railway, where the water supplied is of medium quality, the side sheets of steel boxes in new engines required renewal inside twelve months, or after running about 45,000 miles. Hence the labor expended in making steel boxes was as much, or more, than in making copper boxes, and totally, with labor for repairs, it was safe to assume that it was five times as great. Where labor costs as much, or more, than the material used in the box, this reduces the relative cost of the two boxes to about the same figure. This reduces the considerations to the relative time engines fitted with either kind of box would spend in the shops directly consequent to the copper or steel fire-box. Evidently, if a steel box required more frequent repair, the comparison would be in favor of copper.

Another important consideration is the greater reliabilit of one material by which engine failures, or delays, might b less than with the other. Copper is more resistant to corrosion than iron, being higher in purity than mild steel, and electrolytic copper, while equally as ductile and tenacious as that produced by smelting and rolling, is even purer.

As to tensile strength, copper is almost equal to very mild steel, and in ductility very much higher. It is, therefore, less physically damaged by the punishing operations of riveting and beading than steel, and makes a tighter and more tenacious joint than steel with the tubes or flues.

In conclusion, the author stated that the initial cost of a copper fire-box was much higher than steel. The life cost, allowing for the value recovered on the scrap copper, of copper and steel, was about equal. Copper sustains mechanical work better, and makes stronger and tighter joints than steel. It takes up sudden fluctuations in temperature more quickly and uniformly. Copper offers greater resistance to corrosion than steel. Therefore, engines fitted with copper fire-boxes should spend less time in shop directly consequent to fire-box trouble, and be less liable to failure on the road from leaking of stays and tubes and cracking of plates.

FREIGHT (2-6-6-2 TYPE) AND PASSENGER (4-6-2 TYPE) LOCOMOTIVES FOR A LOW GRADE LINE

CAROLINA, CLINCHFIELD AND OHIO RAILWAY.

Running almost directly north and south from Elkhorn City, Ky., to Spartanburg, S. C., and passing through sections of three other states, the Carolina, Clinchfield and Ohio Railway has been constructed largely for handling coal from the West Virginia fields. The line is built in the most modern manner throughout, with no hesitating at expensive cuts and tunnels or extensive trestle work to obtain the straightest line with a minimum grade. The result is that, opposed to loaded traffic, the chased last year from the Baldwin Locomotive Works in order to determine accurately the possibilities of the Mallet under the local conditions. That locomotive weighs 342,000 lbs., of which 330,000 lbs. is on driving wheels, it being of the 2-6-6-2 type. It has been found that it will very comfortably handle a train of 4,000 tons, and the result of its service has been so satisfactory that the road is now receiving from the same builders 10 more Mallet compounds, which, while not excessively large, are some-

POWERFUL FREIGHT LOCOMOTIVE BUILT AT BALDWIN'S FOR THE CAROLINA, CLINCHFIELD AND OHIO RY.

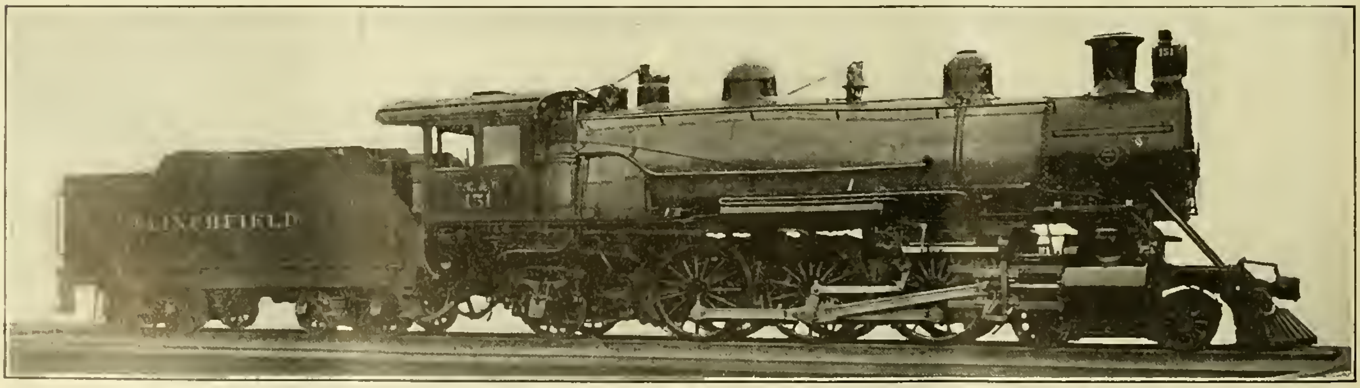
maximum grade is but one-half of one per cent. and the sharpest curve on the line is 8 degs.

A road of this character handling principally a commodity like coal permits trains of large tonnage to be moved unbroken from one end of the line to the other and offers apparently almost ideal conditions for the general use of articulated compound locomotives, and it is this type that is being generally purchased as the road begins to handle the tonnage for which it was designed.

An experimental locomotive of the articulated type was pur-

what more powerful than the experimental engine. In the same order were also included three passenger locomotives of the Pacific type.

Practically no novelties or unusual construction has been included in the design of the freight locomotives. They are also of the 2-6-6-2 type and have 57 in. drivers. While the boiler is very large, it is not as long as many of those recently turned out by the same builders, and does not include a feed water heater or separable joint. A Baldwin superheater has been installed in the front end and acts as a reheater between the

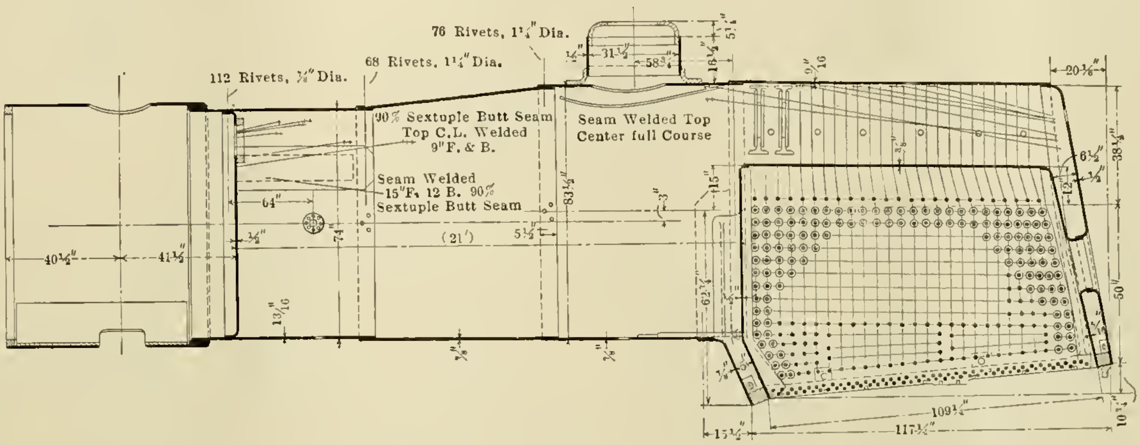


THREE PASSENGER LOCOMOTIVES OF EXCEPTIONAL CAPACITY WERE ALSO BUILT.

high and low pressure cylinders. An examination of the ratios shows the steam making capacity to be ample and the proportion of the grate area to heating surface to be well suited for a first class grade of coal, such as will be available in this district.

In general the design follows very closely what might be called standard practice, if it be conceded that the Mallets have reached a standard. The boiler is equipped with a radial stay firebox, which has 404 flexible staybolts grouped in the outside rows on the sides and back, and in the upper corners of the sides. Flexible stays are also used in the triangular areas in either side of diameter. Those on the high pressure cylinders have inside admission, while the low pressure have outside admission. A flat plate type of relief valve is applied to the top of the steam chest in a manner customarily used by these builders. The valve gears are controlled by a Ragonett power reversing gear, the reach rod between the high and low pressure reversing shaft being carried along the center line of the locomotive, with a universal joint at the high pressure cylinders.

The frames are of cast steel 5 in. in width and the arrangement and construction is the same as customarily used by the



BOILER OF THE PASSENGER LOCOMOTIVES.

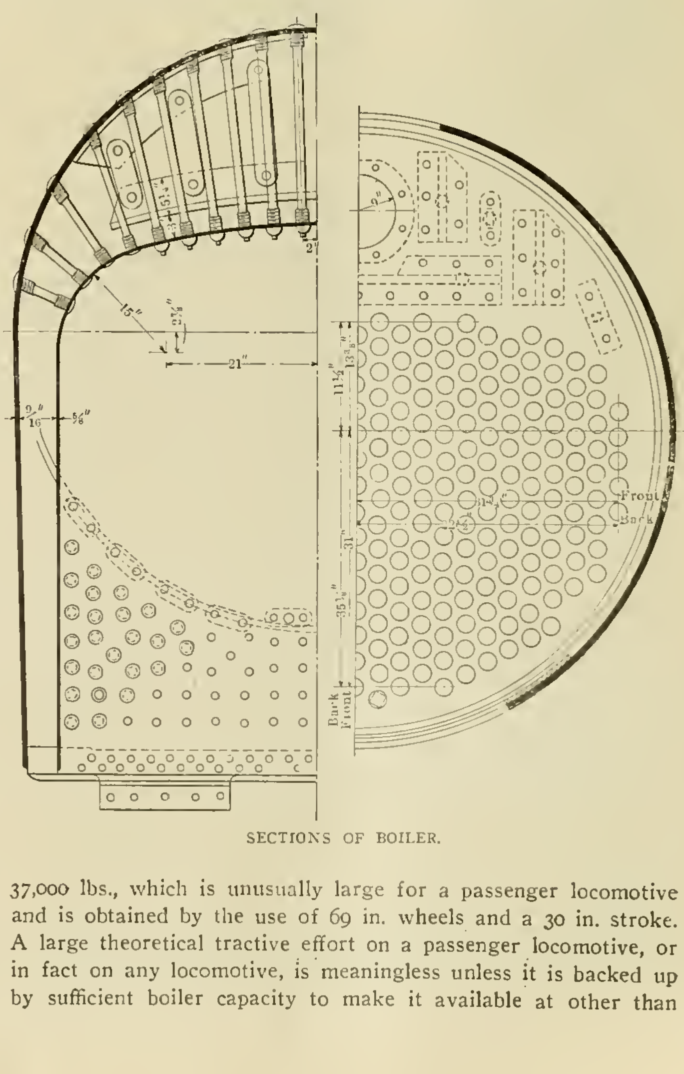
the throat sheet. The dome is placed on the center of the three rings of the barrel, and is directly above the high pressure cylinders; 448 2¼ in. flues, 21 ft. in length in an 86 in. diameter shell permits a very liberal width of bridges and satisfactory general arrangement. This gives a heating surface in the tubes of 5,519 sq. ft., the total heating surface being 5,752 sq. ft. or 73.8 sq. ft. per square foot of grate area.

The boiler is supported on the rear frames by means of a plate at the back end of the mud ring and sliding bearings on the front in the usual manner. It is also supported at the high pressure cylinders, the distance from the center of the cylinders to the face of the throat sheet being 10 ft. 4⅝ in. There is further a plate support at the high pressure guide yoke, which is about 28 in. ahead of the throat sheet. On the front frames there is but one actual support, which is located midway between the second and third drivers and 92 in. ahead of the joint, which is in the builder's customary location on the center line of the high pressure cylinders. This sliding bearing is arranged in the usual manner with a renewable friction plate, its surface being 19 in. above the top of the frames. The centering springs for the front group are located midway between the first and second drivers of this group, 64 in. ahead of the bearing plate. This point, while normally clearing one-half inch, can take a bearing in case of necessity and relieve the main bearer to some extent.

High pressure steam is carried from the dome to the top of the high pressure valve chest through outside pipes in the customary manner. The exhaust from these cylinders is led forward through two pipes along the outside of the boiler to the connection with the reheater in the front end, the arrangement being similar to that used on the Southern Pacific locomotive (see AMERICAN ENGINEER, May, 1909, page 181). From the reheater it passes downward through a pipe having two ball and a sliding joint to a passage in the frame casting on which the low pressure cylinders are supported. From here it goes to the cylinders through two short elbow pipes. The exhaust opening from these cylinders is just above the steam inlet and elbow pipes carry it forward ahead of the cylinders, where they unite into a T shape casting and the return is made through a flexible connection to the exhaust nozzle. The carrying forward of the exhaust line in front of the cylinders was made necessary by the very short distance between the center of the low pressure cylinders and the exhaust pipe—about 44 in. Piston valves are used throughout, they being of duplicate design 15 in. in builders for this type of locomotive, which has been illustrated very thoroughly in these pages.

PASSENGER LOCOMOTIVES.

Three very powerful Pacific type locomotives comprise the order for passenger engines, being delivered with the freight engines. These locomotives have a theoretical tractive effort of



SECTIONS OF BOILER.

37,000 lbs., which is unusually large for a passenger locomotive and is obtained by the use of 69 in. wheels and a 30 in. stroke. A large theoretical tractive effort on a passenger locomotive, or in fact on any locomotive, is meaningless unless it is backed up by sufficient boiler capacity to make it available at other than very low speeds. This feature in this case is well taken care of not so much by the actual amount of heating surface as it is by the large size of the boiler and the liberal spacing of the flues. The B. D. factor of 625 and a ratio of heating surface to cylinder volume of 283 do not clearly indicate the probable steam making capacity of the boiler. When it is considered that this boiler is 74 in. in diameter at the front end, is of the extended wagon top type, and measures 83½ in. at the connection to the fire box, and that it contains 317 2¼ in. tubes, 21 ft. in length, it is evident that with a good grade of fuel it will be possible to make and free all the steam necessary and that the steam storage space is sufficient to furnish a reasonable dry supply for the cylinders. The fire box is somewhat similar to the Mallet locomotives, although it has not as wide a grate. The side sheets are practically vertical and there are 386 flexible stays distributed on the back head and side and throat sheets. The Master Mechanic style of front end is used with a long inside extension of the stack and an adjustable diaphragm plate in front of the nozzle. It is self clearing and no cinder hopper is provided.

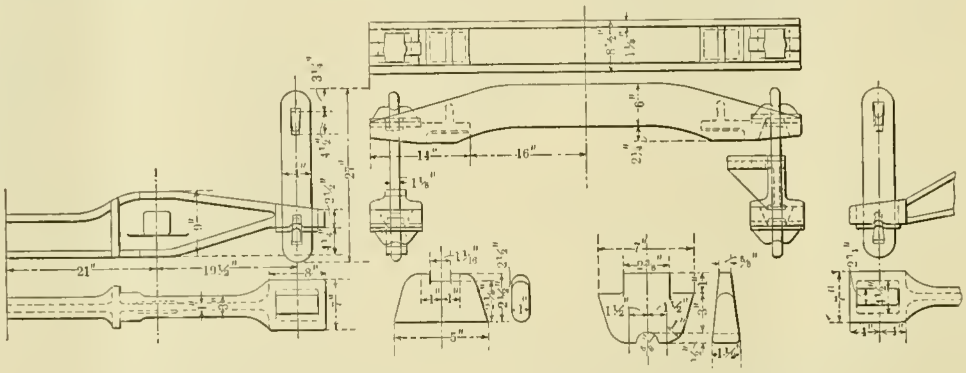
Cast steel main frame 5 in. in width extend from in front of the forward pedestal to the tail casting, the trailing frames being integral with them. The front frames are of forged iron, being single on each side and hooked and double keyed into the main frame, being secured by 4 1½-in. vertical bolts. At the point of connection to the cylinders the frame has a section of 4½ x 7 in.

A radial type trailing truck with outside journals and remarkably simple design has been employed. The journal box was secured to the radial frame and the swing motion is allowed by the movement of the spring links, which are set on flat keys at each end arranged to permit free side motion and a limited amount of fore and aft motion. A semi-elliptical spring rests on top of the box and is carried in a cast steel frame to which the spring links are connected. The whole construction offering practically no resistance to the side motion of the truck. The spring and its frame work are held in place by an extension from the sides of the journal box.

Fifteen inch piston valves of the same design as were used on the Mallet locomotives are here employed. The valve chambers are set inside and 18½ in. above the cylinder centers, which permits a very satisfactory and direct arrangement of the steam and exhaust passages. This location of the valve chamber necessitates the use of a rocker arm in the gear, which is carried from an extension on the guide yoke and connects to the valve stem through a cross head connection, the stem being guided at the back end. The valve gear is straight forward in design, the link being supported by the usual longitudinal bearers outside of the driving wheels. The center of the link is placed 23½ in. above the center of the axle, the cylinder centers being 1½ in. above the axle. The link from the reversing shaft connects to the radius bar at a point 16 in. in front of the block.

Twelve inch channels make up the sills of the tender frame, the center sills weighing 40 lbs. per ft. and the side sills 25 lbs. The tenders for both the freight and passenger engines are similar in design, the former, however, being of somewhat larger capacity. The trucks for both are of the arch bar type, the passenger engines having steel tired wheels, while the freight tenders have been fitted with solid rolled steel wheels. The freight engines have a 10,000 gallon tank and a capacity for 15 tons of coal, while the passenger engines have an 8,000 gallon capacity tank and 14 tons of coal.

The general dimensions, weights and ratios are given in the following table:



EQUALIZERS AND SPRING HANGERS AT TRAILER TRUCK OF 4-6-A TYPE LOCOMOTIVE.

GENERAL DATA.		
Type	2-6-6-2	4-6-2
Fuel	Bit. Coal	Bit. Coal
Tractive effort	77,500* lbs.	37,000 lbs.
Weight in working order	378,650 lbs.	233,050 lbs.
Weight on drivers	325,850 lbs.	152,900 lbs.
Weight on leading truck	24,600 lbs.	42,750 lbs.
Weight on trailing truck	28,200 lbs.	37,400 lbs.
Weight of engine and tender in working order	550,000 lbs.	385,000 lbs.
Wheel base, driving	31 ft.	13 ft.
Wheel base, total	46 ft. 6 in.	34 ft.
Wheel base, engine and tender	74 ft. 11 in.	65 ft. 10 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.22	4.13
Total weight ÷ tractive effort	4.88	6.30
Tractive effort x diam. drivers ÷ heating surface	767.00	625.00
Total heating surface ÷ grate area	73.80	75.80
Firebox heating surface ÷ total heating surface, %	4.06	4.70
Weight on drivers ÷ total heating surface	56.80	[illegible]
Total weight ÷ total heating surface	65.80	57.00
Volume equiv. simple cylinders, cu. ft	23.70	14.40
Total heating surface ÷ vol. cylinders	242.60	283.00
Grate area ÷ vol. cylinders	3.29	3.74
CYLINDERS.		
Kind	Compound	Simple
Diameter	24 & 37 in.	23 in.
Stroke	32 in.	30 in.
VALVES.		
Kind	Piston	Piston
Diameter	15 in.	15 in.
Outside lap	1⅛ in.	——
Inside clearance	¼ in.	——
Lead	¼ in.	¼ in.
WHEELS.		
Driving, diameter over tires	57 in.	69 in
Driving, thickness of tire	3½ in.	3½ in.
Driving journals, main, diameter and length	11 x 13 in.	10 x 13 in
Driving journals, others, diameter and length	10 x 13 in.	9 x 13 in.
Engine track wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ x 12 in.	6½ x 12 in.
Trailing truck wheels, diameter	33 in.	45 in.
Trailing truck, journals	6½ x 12 in.	8 x 14 in.
BOILER.		
Style	Straight	W. T.
Working pressure	200 lbs.	190 lbs.
Outside diameter of first ring	86 in.	74 in.
Firebox, length and width	117 x 96 in.	108⅛ x 71¾ in.
Firebox plate, thickness	⅜ & ½ in.	⅜-5/16-½ in.
Firebox, water space	F 6, S. & B, 5 in.	F. 5, S. & B., 4 in.
Tubes, number and outside diameter	448—2¼ in.	317—2¼ in.
Tubes, length	21 ft.	21 ft.
Heating surface, tubes	5,519 sq. ft.	3,903 sq. ft.
Heating surface, firebox	233 sq. ft.	192 sq. ft.
Heating surface, total	5,752 sq. ft.	4,095 sq. ft.
Grate area	78 sq. ft.	54 sq. ft.
Center of boiler above rail	122 in.	112 in.
TENDER.		
Tank	Water bottom	Water bottom
Frame	12 in. chan.	12 in. chan.
Wheels, diameter	33 in.	36 in.
Journals, diameter and length	6 x 11 in.	5½ x 10 in.
Water capacity	10,000 gals.	8,000 gal.
Coal capacity	15 tons	14 tons

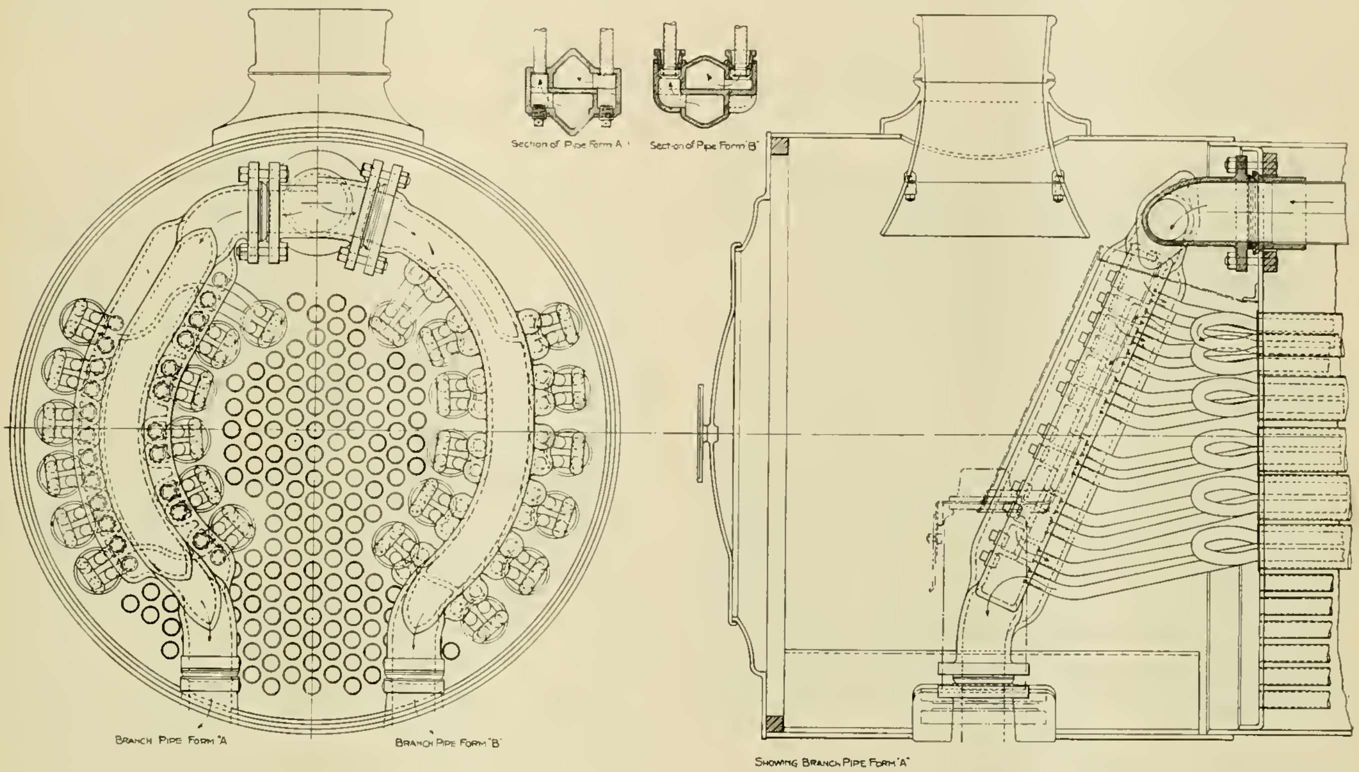
$$* \frac{1.2\ P\ d^2\ s}{D} = \text{T. E.}$$

d = Diam. H. P. cylinder.

During 1909 a total of 177,802 trains were dispatched from Grand Central terminal, New York, averaging one train every three minutes for the whole twenty-four hours. The delay in dispatching aggregated 36,563 minutes, an average detention of twelve seconds per train. The total length of these trains, placed end to end, would be 14,143 miles.

A NEW LOCOMOTIVE SUPERHEATER.

An interesting development of high degree locomotive superheater is shown in the accompanying illustration. This arrangement incorporates a double looped unit enclosed in a large boiler tube in the same manner as other fire tube superheaters. The chief difference in the arrangement in this case is in the headers, which have much the same appearance as the ordinary steam pipes at the front end, using the same arrangement of ball connections to the T head and cylinders. Each of these headers is separated by interior walls into two chambers, connection between each is only obtained through the medium of the superheater pipes.



HIGH DEGREE LOCOMOTIVE SUPERHEATER OF SIMPLE DESIGN.

Two designs of headers are shown; the one marked "A" has its tube connection bosses and ports formed within the pipe and the tubes are expanded into the bosses. In the form marked "B" the tube connection is formed outside of the header, the tube ends being expanded into collars, which have a ball joint seat on the header and are secured by a locking block. This block is constructed to take care of all uneven expansion.

In the event of a mishap to the coil with the form "A" header it is necessary to remove the front plug and cut the coils with the tube cutter. Then the element can simply be revolved and drawn out of its large tube without disturbing any other part of the superheater. In the form "B" it is simply necessary to release the collar connection to the header and revolve the element in the same manner as above. It is easily and quickly removed. The most noticeable advantage of this arrangement is the comparatively small obstruction in the front end that permits convenient attention and repair to the regular boiler tubes and also the possibility of using the regular front end arrangement of diaphragms and nettings.

In general this design is similar to the Emerson superheater that is now being applied to quite a large number of locomotives (See AMERICAN ENGINEER, February, 1910, page 65). It has an advantage over that arrangement, as used on the Great Western locomotives, in convenience for removing the superheater elements and giving more room in the front end for removing boiler tubes.

This design has been patented by Willis L. Riley, of St. Paul.

ELECTRIFICATION OF THE SALT LAKE & OGDEN RY.

The electrification of the Salt Lake & Ogden Ry. has been completed. The service at present will consist of a train every 45 minutes out of Salt Lake City, Utah, for Lagoon after 2 P. M. every day, and a through train out of Salt Lake City for Ogden and intermediate points beginning at 6:10 in the morning and continuing until 11:45 at night. It will require only 30 minutes to make the run between Salt Lake City and Ogden. The cars will be operated in trains under multiple unit control.

For the present, trains will be run to the old station on West Third street, but as soon as possible a station will be constructed on Richards street, and the cars brought to that place. A new station has been built in Ogden at the corner of Lincoln avenue and Twenty-fifth street, a block east of the union depot. The cars are of special design, 56 ft. long, and weigh 38 tons. A new power plant is now under course of construction at Lagoon, and will be completed within the next six months. Until that time power will be furnished by the Telluride Light & Power Co.

All freight will be transported at night. It is proposed to keep the line free from all construction trains until the end of the busy season, when the double tracking will be completed. A block system is being installed and at all danger points already is ready for use. For the present, freight trains will be hauled by steam locomotives and later by electric locomotives.

MOTOR CONTROL AND MACHINE OUTPUT.—The output of a machine tool motor depends, to a considerable degree, upon the convenient arrangement of the control and the importance of the arrangement from the standpoint of the operator cannot be ignored, since the output of a tool will be materially increased when an operator can start and stop the tool and obtain at all times maximum cutting speeds by simply turning a handle. The controller must be placed in a safe position and should be accessible for repairs, which very often means that some arrangement is necessary to bring the operating handle within easy access of the operator, as for instance the arrangement commonly seen on lathes where the operating handle travels with the tool carriage.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

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Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS

COLLEGE MEN IN THE SHOP.

Before the Society for the Promotion of Industrial Education, Frederick W. Taylor, who is probably as well qualified to speak authoritatively on the subject as any other man in the country, gave briefly his explanation of why manufacturers dislike college graduates and suggested one way in which this fault could at least be partially overcome. This consists primarily of requiring college men to spend at least a year in a regular shop between their freshman and sophomore years in school. The reasons for doing this, as advanced by Mr. Taylor, differ from those which have accompanied the same suggestion previously from other sources and seem to reach into a very vital part of the problem.

HORSE POWER OF THE FIREMAN.

It has been mentioned in this column a number of times that, until the automatic stoker comes into general use, the main object and aim of improved locomotive design is to increase the net return of the fireman's work. That the Mallet compound locomotives mark a tremendous advance in this direction is generally known, but it probably is not generally understood that an advance of practically 100 per cent. has been made by the introduction of this type of locomotive; in other words, that it permits one fireman to develop practically double the draw bar pull that was previously his maximum.

Service tests on the lines of the Delaware & Hudson Company, that are reported on page 345 of this issue, show this fact very clearly. The Mallet, which has exactly the same amount of grate area as the consolidation type pusher, did an amount of work equal to two of these engines with practically the same amount of coal used on one of them. Even then this amount was not as large as firemen have shown themselves capable of handling per hour for a somewhat longer period than was required on this run. When one fireman can develop practically 100,000 lbs. of draw bar pull for two hours continuously, who dares to say what tractive effort will be obtained from locomotives when the automatic stoker becomes thoroughly perfected, a condition which now does not seem to be so far in the future.

IMPROVEMENTS IN MACHINE TOOLS.

It was only four or five years ago that 16 to 18 pairs of steel tired wheels were the record output for a car wheel lathe and in fact even to-day there are comparatively few shops which can do as well as this. The record now, however, is practically twice that number, standing at 33 pairs of 36 in. wheels turned in less than ten hours. This test at West Albany, which is chronicled on page 368 of this issue, has also been nearly equaled in the average time per pair by at least one other test.

This advance in the design and construction of the car wheel lathe is but an instance of the general improvement which is constantly going on in the machine tools for railroad uses. The builders of all classes of tools for railroad shops are not only keeping well up to the rigid and in some cases seemingly impossible requirements of the users, but in many instances are forging ahead of the demands. Any one who has followed the descriptions of new tools that appear in these columns each month cannot help but be impressed with the fact that the advance being made in this field appears to be moving at a constantly increasing rate of acceleration. These manufacturers are obtaining some of the best mechanical talent in the country and are making full use of it. Further, they are not confining themselves to building machines which will give the best results with the present methods of performing any operation, but are getting back of this and discovering new and better ways of doing the work and then building machines to give the best return by the best method. The reduced operating cost of many railroad machine shops is undoubtedly due to a large extent to the activity and talent of machine tool builders.

LOCOMOTIVE TERMINALS*

WILLIAM FORSYTH.

The most interesting example of American engine house practice is that in the classification yards of the Pennsylvania Railroad at East Altoona, Pa. Here the traffic from three divisions of the road is concentrated, classified and despatched. The freight tonnage passing through this terminal is claimed to be the largest handled by any single system of freight yards in the world. The total capacity of the yards is 10,500 cars.

The eastbound traffic is composed largely of loaded coal and coke cars, and the number of cars handled per month in this direction is: loaded, 61,308; empty, 1,306; total, 62,614. The westbound movement is composed largely of empty cars, with a total of 62,877 cars per month. In 1906 an average of 90 trains per day was received from the Pittsburg division and 60 from the Middle division, and the movement in one direction reached as high as one train every ten minutes for six hours. During the month of November, 1909, the engine movement at this engine house was as follows:

Average number of locomotives despatched east and west in 24 hours	243
Maximum number despatched in 24 hours	290
Maximum number despatched in one hour including switch engines	40

The trains are operated by consolidation locomotives, and on account of the grades on the eastern slope of the Allegheny mountains westbound trains require three engines, two in front and one as a pusher. Eastbound, the line follows a comparatively light gradient along the Juniata river, and here large trains can be handled by one consolidation engine. There are 35 switch engines, requiring 70 engine crews for day and night operation. During the month of November, 1905, there were handled over the ashpit a total of 64,497 engines. The number of men employed in the yards is 1,830. The number of engine men employed during the month averaged 1,012 and the number of men employed about the engine house, shops and coal wharf and on the motive power roll was 700.

Near the center of the length of the terminal is located a large engine house with ashpits, coal wharf, sand supply, a good-sized machine shop, storehouse and office, with bunk rooms overhead; also a power house, a fan house for heating, an oil house, and a toilet and locker house.

THE ENGINE HOUSE.†

The engine house is in diameter and cross-section the largest structure ever erected for this purpose. It has an exterior diameter of 395 ft. and a turntable of 100 ft. There are 52 stalls 90 ft. deep. The main portion of the house is 65 ft. wide and 30 ft. high. On the outer circle there is a lean-to 25 ft. wide and 18 ft. high. The engines head in toward this lean-to and the smokejack is located alongside the main columns at the outer portion of the main building. The main portion of the house was made 30 ft. high to accommodate a traveling crane, but columns for supporting the crane have not been erected, as jib cranes secured to the main columns were found more desirable.

The turntable is operated by an electric motor. There are four drop tables, also operated by electric motors, two of them for driving-wheels, one large table for all wheels except the engine trucks, and another for pony truck wheels.

The coal wharf is a large structure arranged with a trestle approach having a grade of 3.88 per cent. The coal is dropped from hopper cars directly into bins and no cover is provided for the cars, as they are emptied entirely by gravity and no men are employed in the unloading. The storage structure is 32 ft. wide and 216 ft. long. A special gate and hood are used for regulating the flow of coal from the pockets to the tender. A steel gate drops below the floor of the pocket and is operated by a compressed-air cylinder.

At one end of the coal wharf is a sand house, where sand is dried in large stoves and descends through a grating to a reservoir, from which it is elevated by compressed air to the sand bins overhead, and flows by gravity to the engines.

Near the approach to the coal wharf are four ashpits, each 240 ft. long, two on each side of the wharf incline. Each pair is operated by an overhead 5-ton electric crane which spans four tracks, two of them over the ashpits for ash cars. Ashes are dumped from the engines into steel buckets which run on wheels on a track in the ashpit. These buckets are elevated by the crane and transferred to the ash car, where they are dumped. Beyond the ashpits at the extreme end of the coal wharf are inspection pits, 80 ft. long and 3 ft. deep, and connected by an underground passage extending under the coal wharf track.

ENGINE HOUSE ORGANIZATION.

The work performed in an engine house includes almost everything in connection with locomotive repairs that does not require the locomotive to be sent to the general repair shop. No attempt will be made to itemize these repairs. The work which must invariably be performed periodically consists of boiler testing every six months; boiler washing, from once a week to once a month as necessity arises; staybolt testing each week; examination of smoke-box, draft arrangements and ash pans, each week; testing steam and air gauges each month; washing tenders each month; gauging height of pilots each week; gauging tank water scoops each trip; testing air brakes each trip; draining main reservoirs each week.

Manner of Reporting and Performing Daily Work.—When a locomotive arrives the first information the organization receives as to work necessary is in the engineer's report which he delivers at the inspection pit when the locomotive is turned over to the inspectors. Five inspectors are here employed, as the work must be done thoroughly in a minimum time, so that the hostler can move the locomotive to the ashpit and make room in the inspection pit for other locomotives waiting. One inspector examines the under-part of the locomotive and tender; one on each side inspects the outside parts, such as driving wheels, rods, steam chests, guides, crossheads and Walschaert valve gear; there are two air-brake inspectors, one to operate the brake valve and inspect the fittings in cab and air pump, and the other to inspect all other parts of the air and sanding equipment.

All defects found by the inspectors are entered upon regular blanks and transmitted, together with the engineer's report, to the gang leader in charge at the inspection pit, who decides whether it is necessary to send the engine to the house or whether the repairs are so slight that they can be made on the outside repair pits in connection with the outbound storage tracks. His decision is marked upon the report, and upon the steam chest of the locomotive, and the reports are forwarded to the work distributor's office by pneumatic tube‡ in 45 seconds. This saving in time over the 10 minutes ordinarily required by messenger is a decided advantage to the work distributor, as he is able to assign the work to various gang leaders, and have the necessary material ordered, before the locomotive arrives in the house or on the engine track.

While the inspectors are at work the lamps and torches are filled and trimmed by two lamp fillers. There is no further necessity for the engine house force to open the tool boxes, which are locked by the engineer, and the keys, together with his time card, delivered to the engine despatcher at the foreman's office. The engineer is then relieved of all responsibility and of the care of the locomotive.

The engine moves from the inspection pit to the ashpit, where

* Presented before the joint meeting of the A. S. M. E. and I. M. E. at Birmingham, England, July 25, 1910.

† For full description of this engine house and terminal, see AMERICAN ENGINEER, Feb., 1906, p. 46; Mar., 1906, p. 81.

‡ See AMERICAN ENGINEER, Feb., 1910, page 50, for illustrated description of this arrangement.

the firebox, ash pan and smokebox are cleaned. It then moves to the coal wharf, where the tender is filled with coal; and a little farther on reaches the sand house, where it receives a supply of sand and water. It then moves into the engine house or to the outbound storage tracks, as necessity requires. If it goes to the engine house the track number and the time of arrival are reported by telephone by the turntable motorman to the work distributor, who by this time has the work which was reported by the inspector and engineer subdivided and assigned to various gangs. After completing the work these gangs report the locomotive ready for service to the engine house office, where arrangement is made for the movement of the locomotive to the storage siding to await assignment to a train. If the locomotive does not go to the engine house it is moved directly from the sand house to the storage siding, and the necessary work is assigned to a gang located on the storage tracks to make light repairs, after which the locomotive is reported ready for service.

Engine Tracing.—At East Altoona there are sometimes as many as 200 locomotives within the engine house jurisdiction and it was found necessary to inaugurate some efficient method of locating them exactly at all times, so that men sent to make repairs will have no difficulty in finding any particular locomotive required. This is accomplished by telephone. Each time a locomotive moves to another locality the engine tracer in the foreman's office is advised as to where it came from and where it has been delivered, giving the number, the location on the track and the time in each case. When traffic at East Altoona is normal the engine house must deliver ready for service one locomotive every five minutes during the whole 24 hours of the day, as the engines for three divisions are here concentrated. It is vitally important that everything should run in absolute harmony as any interruption in this rapid flow would quickly result in a congestion on the road.

Engine Despatching.—After the engine tracer has been advised that a locomotive is placed on the storage track for service, he informs the engine despatcher, to whom the crew callers report. The engine despatcher is also in touch with the yardmaster and is the middle man between the engine house foreman and the yardmaster. As soon as the yardmaster receives information that he needs a locomotive and crew for a certain train of a given class at a certain time, he advises the despatcher, who immediately calls out a crew, and when they arrive assigns to them the locomotive selected, which is standing on the outbound storage track. A telephone system has been installed whereby all crews may be called. The houses of the engine men have been equipped with telephones connected with the engine house office, an arrangement which dispenses with messengers and enables the crews to be called very promptly.

The fireman usually arrives first, and after receiving his time card and keys he takes charge of the locomotive, relieving the engine watcher of any further responsibility, and immediately prepares a fire for road work. The engineer, upon arrival, after receiving his time card at the engine house office and inspecting the bulletin board to read any new orders, goes to the locomotive and oils the machinery, and then waits until he is given the proper signal to move out of the storage yard. The crews are usually called in sufficient time to prepare the locomotive properly for road work prior to leaving the storage track.

Organization of Staff.—For the operation of this locomotive terminal an elaborate organization has been worked out, based upon the principle that none but the heads of sub-departments shall report to or receive instructions from the foreman, his assistant or the work distributor. The responsibility of supplying material and the supervision of the workmen are placed directly upon these gang leaders, who are foremen of their respective gangs. Certain questions of discipline must be handled by the foreman personally, but questions relating to rates of pay, transfers, discipline, etc., ought to originate with the gang leaders, and their duties not be confined to giving out work to the men after the distributor has assigned it. This results in successful operation, but it also gives some dignity to the position of gang leader, and at the same time relieves the foreman of petty details.

The foreman of a large engine house should not be an ordinary shop man, but should have some outlook over and interest in the operating department. He should be a good disciplinarian, commanding the respect of his men, should display clear judgment and form conclusions quickly. He should be a good all-round organizer and capable of taking care of business promptly during rush hours. He should know how to make brief and intelligent reports and possess mechanical ability. He should be broad-minded enough to recognize that there is a commercial side to transportation, and should not be overburdened with office work. His assistants should possess sufficient ability to decide what work may be slighted or not done at all, and a locomotive still be safe to make one or more round trips.

The engine house foreman receives from the division master mechanic instructions pertaining to such matters as the number of men required, rates of pay, discipline, maintenance of his entire plant, and standards. He receives from the division superintendent instructions relating to crews and despatching of locomotives, and carries out such discipline of the engine crews as may be imposed by the division superintendent through the road foreman of engines. He must co-operate with the road foreman of engines concerning the condition of power and its performance on the road, and the amount of coal and oil consumed. He must carry out orders issued by the road foreman of engines concerning the assignment of locomotives and crews. At East Altoona the engine house operation is a continuous one throughout the day and night, and the night force is practically the same as the day force.

Reporting directly to the engine house foreman are the assistant day foreman and assistant night foreman. Reporting to assistant foremen for office work are the first clerk, who takes all the foreman's and the assistant foremen's dictation, and the second clerk, who has charge of all messengers and ordinary clerks who may be engaged in computing the time and earnings of the men and in getting together all the information required by the master mechanic's shop clerk and for properly keeping the records. Next in order is the engine despatcher, to whom report the engine tracer, the callers and the clerks who keep the records of engineers and firemen and of locomotives arriving and departing. The engine despatcher marks up the crew board, issues time cards to engine crews going out, and accepts and approves them upon their return.

Next in order reporting to the assistant foreman are the various gang leaders. First is the gang leader in charge of the machine shop. The work of his men is confined to machine and vise work, and they are not called upon to leave the machine shop and make repairs in the locomotive shop or storage yard except in cases of emergency. Their work is chiefly preparing and fitting the repair parts which the engine house employees apply to the locomotives. The gang leader in charge of the blacksmith shop has charge of all smiths and helpers, as well as the forces of flue welders and laborers in the engine house engaged in piecing flues and preparing them for locomotive boilers. The gang leader of the power plant has full charge of stationary engineers and firemen, electricians and wiremen. Another gang leader has charge of the ordinary helpers and sweepers in the engine house, who keep the shop property clean.

The foreman in charge of all employees actually handling locomotives, from the time they arrive at the terminal until they are turned out, also of all workmen engaged in the engine house or storage yard, is called the work distributor. Clerks reporting to his two assistants receive the engineers' and inspectors' work reports and copy the work required on slips of paper numbered consecutively and properly dated. These slips are then delivered to the gang leaders of the men who perform the work.

The men composing the gangs working on a piece work basis are divided into pools of three or four men, with leaders. The pool leaders are under the direction of gang leaders. When the earnings of three or four workmen are pooled it is found that each man is determined that the others should perform their fair share of work, and in case one man fails to do this the remainder insist that the lazy or careless workman be taken out of their pool.

The gang leaders at the inspection pits are in charge of inspectors, lamp fitters and engine preparers, who handle the locomotives between the inspection and ashpits.

There are three assistant gang leaders in charge of the engine preparers. Assistant No. 1 has charge of all work in cleaning fires and placing the locomotives in the engine house or storage yard and of the ashpit men and crane operators who load cinders. Assistant No. 2 has charge of the coal gaugers and sand house men, turntable operators and men engaged in handling locomotives from the engine house to the storage yard. Assistant No. 3 has charge of the men handling locomotives in the storage yard and despatching them when ordered for service, including engine watchers, switchmen and engine timers.

Next reporting to the work distributor is the gang leader of boiler washers, whose men wash out the tenders, blow out, wash, fill and fire all boilers, and watch locomotives until they are removed from the engine house. Next is the gang leader of staybolt inspectors, whose men test staybolts and examine fireboxes and tubes. There is a gang leader of boiler makers, engaged in renewing tubes and staybolts, patching, testing and calking tubes, and general boiler work. A gang leader of engine cleaners has charge of men cleaning locomotives and tenders. There is a regular schedule for doing this work, and it is so arranged that the work is performed when the locomotives are receiving staybolt repairs or boiler washing. A gang leader of spongers is in charge of packing journal boxes and other work relating to lubrication. In the engine house there is a gang leader of machinists, who are engaged in setting valves, renewing packing and all other general machinist work on the locomotive proper. The gang leader of tank repairs is in charge of repairs to tenders, frames, tanks and couplers, of renewing truck wheels, and other tender repairs. The gang leader of air-brake repair men keeps in order the air brakes and sanding equipment.

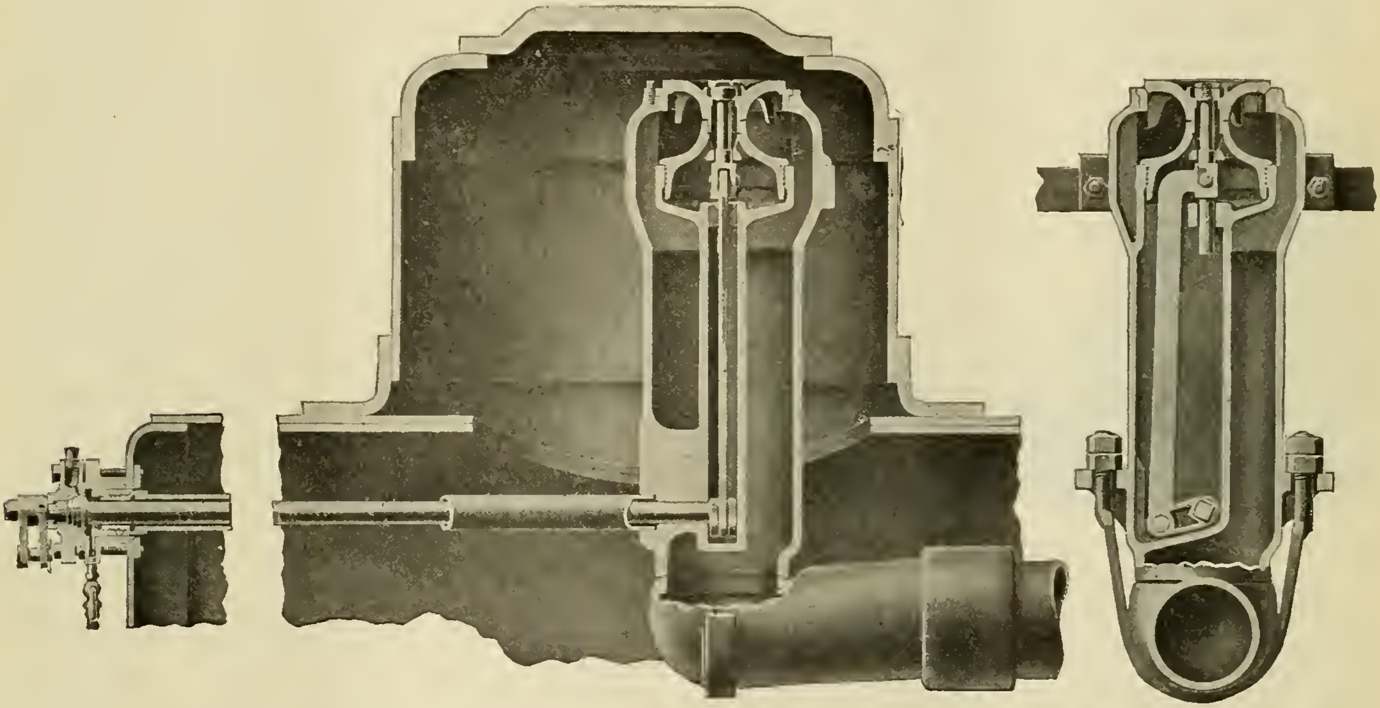
The gang leaders of men on piece work should have not more than ten or twelve men under them, with the exception of the gang on boiler work, which may require from one to four days to complete.

David W. Pye, formerly vice-president of the Safety Car Heating and Lighting Co., has been elected president of the United States Light and Heating Co., succeeding William H. Silverthorn, deceased.

A NEW LOCOMOTIVE THROTTLE VALVE.

The throttle valve in use on most of the present locomotives, although it has rendered satisfactory service for a long time without any particularly apparent need for improvement, is generally admitted to possess some disadvantages that cannot be overcome without changing practically the entire design of the valve. Chiefly for this reason, and because these defects, when compared with those of other locomotive details, are not so prominent and may not appear very important, this matter has seldom received the careful attention justly due a device with so much influence upon the steam quality and consumption.

With the usual style of throttle valve it is almost impossible for inspectors to enter the steam dome without disturbing the dry pipe, or breaking steam joints. Usually a large amount of time is required to regrind the valve seats. There have been a number of engine failures on account of accidental disconnections in the throttle operating rigging inside of the boiler. And in addition there is always considerable lost motion in the mechanism due principally to the nature of its construction, which of course makes it impossible to regulate the valve opening as closely as is frequently necessary. This condition has recently led to the introduction of an auxiliary valve on some of the large Mallet compound engines with a further increase in the number of parts in the throttle valve and its operating arrangement.



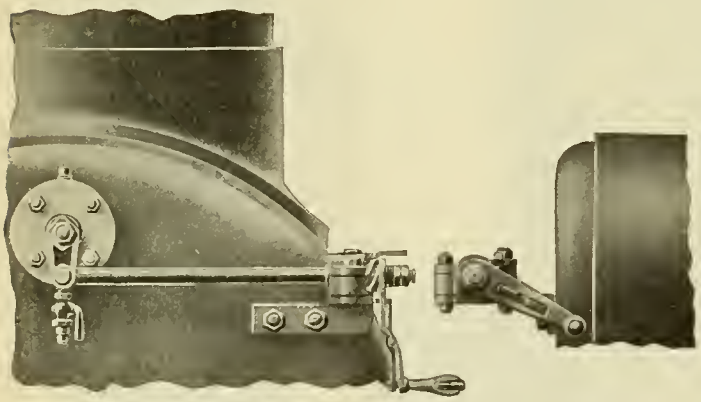
A NEW THROTTLE VALVE THAT HAS MANY IMPROVED FEATURES.

To overcome all these difficulties an entirely new design of valve has been invented by J. S. Chambers, superintendent of motive power of the Atlantic Coast Line Railroad. This valve, known as the Chambers throttle valve, and shown in section in the accompanying illustration, has had service tests of over three years with highly satisfactory results. It occupies less space than the old style of throttle valve and the general simplicity in design of both the valve itself and its operating mechanism, together with a number of other resulting advantages, render it a unique and desirable form of valve, and make it a strong rival of the present type, which will appeal strongly to the motive power department.

In this new design the throttle valve proper consists of a single balanced disc resting on top of the stand pipe, which is unseated by the upward movement of a balancing piston sliding in a finished cylindrical seat and telescoping at the top over the reduced end of the valve. The shoulder on the valve stem in its lowest position is just far enough below the shoulder on the under side of the balancing piston to permit a slight raise before it begins to force the piston upward. This preliminary movement unseats a small balancing valve in the top of the main valve, permitting steam to enter the balancing chamber under the piston, and thus perfectly balancing the main valve before it is lifted for admitting steam.

The lifting rod fastened at the top to the stem of the balancing valve extends downward within the balancing chamber and connects through the interval crank with the operating shaft which extends backward through the wall of the stand pipe and through the back head of the boiler. Here the operating shaft is connected through the external crank, similar to and placed at right angles with the internal crank, to the transmission rod which extends horizontally along the back boiler head. This rod at its outer end passes through the operating screw, which is held in alignment by the babbited split box secured to a bracket on the boiler. The operating screw is free to rotate upon the transmission rod, but it travels longitudinally in the screw box and imparts this motion to the transmission rod through a collar on one side of the screw and washers adjusted for lost motion and locked on the end of the rod by two nuts, on the other side. The screw and operating handle are riveted together and travel as one solid piece.

The part of the operating shaft within the boiler is surrounded by a pipe casing which is threaded on the inner end



REGULATOR USED WITH NEW THROTTLE VALVE.

into a steam-tight bushing in the stand pipe wall, and on the outer end to an expansion sleeve packed into the stuffing box with metallic packing (to allow for unequal expansion). It will be seen that with a closed throttle the inner end of the operating shaft and the annular space between the shaft and the casing are free from steam pressure unless there is a leak at the throttle valve, balancing valve, or at some interior connection of the stand pipe. Such leakage admits steam to the balancing chamber and ultimately to the drain chamber at the stuffing box, and can easily be detected by opening the test and drain cock, which may also be utilized for blowing out steam occasionally to remove any mud that may find its way into the pipe.

The valve handle in normal position for closed throttle extends away from the operator and is latched to prevent accidental opening. Turning the handle downward and backward draws the transmission rod to the right, rotates the operating shaft, and thus opens successively the balancing valve and the throttle. The amount of throttle opening is indicated by the position of the handle and is limited by a stop on the screw box limiting the handle travel.

As the balancing valve opens, admitting pressure to the balancing chamber, the outward thrust upon the end of the operating shaft is distributed over a number of annular bearing shoulders turned on the operating shaft and working against a babbited bearing in the packing gland, which also serves the purpose of preventing the escape of the steam or condensation that works its way into the back end of the operating shaft casing while the throttle is open. The stuffing box is bolted into place in the usual manner and fitted with a ground, ball joint to conform to any slope of the back boiler head.

The construction of the Chambers valve has been simplified throughout with a view to minimizing inspection and repair expenses. The operating levers being entirely within the stand pipe which is set far toward the front of the steam dome, enables an inspector to enter the dome or make repairs without the usual necessity of having to break steam joints. Accidental interior disconnections in the operating gear are prevented by the absence of loose pins, the only pins used being those on the ends of the lifting rod, which are countersunk at their heads and riveted over on the ends. The forward end of the operating shaft centers itself in a square tapered socket in the internal crank, thus eliminating a pin at this point.

No greater clearance is required on top of the throttle valve than is necessary for the lift, and for this reason the valve may be placed high in the dome and thus deliver steam into the dry pipe with the minimum moisture. As the steam is required to pass through only one valve, there is little counter current or obstruction to impede its flow resulting in less wire drawing and more useful work from the steam. The main valve being single seated, not only does not require frequent regrinding as unequal expansion is never a factor in its operation, but the movement imparted by the steam flow makes it to a large extent self-grinding. Regrinding, when necessary, can usually be effected without removing the valve or seat. If, however, the combined balancing ring and seat is to be machined it may be quickly taken out of the standpipe upon the removal of only three screw bolts.

The Chambers valve is not subject to the troubles resulting from an unbalanced condition of the valve, as the main valve does not open until almost exactly balanced by the steam pressure under the balancing piston. It is evident, too, for reasons explained above, that the end thrust on the operating shaft cannot influence the valve opening. For these reasons the engineer has easy, complete and quick control of the steam admission without the necessity for locking the handle. The regulation of the valve is said to be so close that no special drifting valve is necessary in mountainous sections. Maintenance of an opening as small as 1/64 inch is practical, so that the engineer can admit the requisite small amount of steam to properly lubricate the cylinders and exactly balance the reciprocating parts while drifting down long hills.

The substitution of the rotary for the reciprocating operating shaft overcomes entirely the tendency in the present type of valve to open the valve unduly by forcing the stem outward, as in this case an outward movement of the operating shaft could not influence the regulating movement.

Neither the metallic packing on the end of the shaft casing, nor the babbited shaft bearing are subjected to frictional contact as a means of holding the operating parts. The small duty on the metallic and babbit packing is evidenced by the fact that on the locomotive in three years' constant service these packings did not require any attention whatever.

By referring to the illustrations, it is evident that with a closed throttle, the removal and replacement of the gland and shaft for adjustment or inspection are possible under steam pressure. The apparatus combines the throttle valve, throttle-box and standpipe in a single casting which is held rigidly in the steam dome at the top by a bolted connection and at the bottom is clamped to the dry pipe by a U strap bolt or by two hook straps.

The Chambers valve is manufactured by the Watson-Stillman Co., with offices at 50 Church street, New York.

Safety of Travel on the Pennsylvania System.—As compared with the records abroad, the Pennsylvania Railroad holds a better record, even, as regards the small number of passengers killed than the German state railroad system, noted for its safety. As regards the number of passengers injured, however, several of the European systems are still ahead of the Pennsylvania Railroad; but the record for safety, in general, is of the highest.—*Mach'y.*

POWER CONSUMPTION OF THE MACHINE TOOLS AT THE READVILLE SHOPS.

TESTS TO DETERMINE THE POWER REQUIRED FOR DRIVING THE VARIOUS INDIVIDUALLY DRIVEN AND GROUPED MACHINE TOOLS UNDER LIGHT AND FULL LOAD CONDITIONS AT THE READVILLE SHOPS OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

In the April issue of this journal, a very fully illustrated description of the locomotive repair section of the Readville Shop will be found on page 121. Included in this are illustrations giving the location, size, builder and size of motor driving every tool in the locomotive shop. Reference to those plans and photographs will clearly show the excellent arrangement of the tools in the shop and assist in a clear understanding of the tests which follow.

In the various departments of this whole shop there are 173 motors with a total capacity of 3,160 h.p., all of which are of General Electric manufacture. In the August issue of the *General Electric Review* there was given the results of various tests made on a large of these motors while in operation on the ordinary work.

The average motor load at the switchboard in the power house varies from 600 to 700 kw. and the average lighting and power load from 800 to 900 kw. The percentage of average load to total capacity of motors is thus about 30 per cent. The power factor during the day is about 69 per cent., increasing to 71 or 72 per cent. when the lights are in operation. The entire plant is operated by 25 cycle alternating current. The motors are all 750 r. p. m., 550 volt, Form K induction, with the exceptions as noted in the following table of tests:

80 IN. DOUBLE WHEEL LATHE (PUTNAM), 10 H. P. MOTOR

Load	Kilowatt Input
Rolling axle, speed 15 feet per min	0.5—2.0
Turning axle, 1/64 in. cut, 1/32 in. feed, speed 15 ft. per min.	0.6—1.6

90 IN. DOUBLE WHEEL LATHE (PUTNAM), 50 H. P. MOTOR

Running light	2.4
Full load	28

Load consists of two heavy cuts on driving wheels, ⅜ in. feed, ⅜ in. cut, cutting speed 12 ft. per min. Kind of tool steel—Mushet high speed.

7½ H. P. MOTOR USED TO MOVE TAIL STOCK

Moving forward	1.8
Moving backward	1.8

600 TON, 90 IN. WHEEL PRESS (POND), 25 H. P. MOTOR

Running light	1.4
Pressing 6 in. crank pin from driving wheel	
Average load	2.3
Maximum load when pin started	3.5

Maximum pressure when pin started, 260 tons.

36 IN. X 12 FT. PLANER (PUTNAM), 10 H. P. MOTOR

Running light	1.8
Forward, no load	2.8
Reverse	22.
Back	4.4
Reverse	18.
Forward under load	3.6

Load:
- One 1/64 in. cut, 1/16 in feed on cast iron. Tool steel, Midvale.
- One 1/32 in. cut, 1/16 in. feed on steel. Tool Steel, Syrian. Forward 35 ft. per min. Backward 70 ft. per min.

48 IN. X 16 FT. DOUBLE PLANER (WOODWARD & POWELL), 25 H. P. MOTOR

Running light	2.
Forward, no load	4.
Backward, no load	4.
Forward, under load	13.

Load, two 5/16 in. cut, 1/32 in. feed on cast steel.
Tool steel—Mushet high speed.
Cutting speed—45 ft. per min.

72 IN. X 12 FT. PLANER (POND), 25 H. P. MOTOR

Running light	1.7
Reverse	20.
Forward, no load	2.4
Backward	5.
Reverse	10.
Forward, under load	4.8

Load, 1 cut ½ in. with ⅛ in. feed on cast iron.
Tool steel—Mushet high speed.
Cutting speed—18 ft. per min.
Return feed—54 ft. per min.

72 IN. X 30 FT. PLANER (PUTNAM), 35 H. P. MOTOR

Running light	3.4	
Forward, no load	4.8	
Reverse	32.	5 tons on bed
Backward	9.2	5 tons on bed
Reverse	14.8	
Forward, under load	6.4	

Load, one ¼ in. cut, 1/16 in. feed on cast iron.
Tool steel—Mushet.
Speed forward—30 ft. per min.
Speed backward—65 ft. per min.

CYLINDER BORER, 7½ H. P. MOTOR

Running light	0.76
3 cuts ⅛ in by 1/16 in. feed	4.8
5 cuts ⅛ in. by 1/16 in. feed	5.6

On 3 cuts, cutting speed 17 ft. per min. Tool steel unknown.
On 2 additional cuts, cutting speed 25 ft. per min. Tool steel, one Mushet high speed; one Syrian.

6 FT. RADIAL DRILL (BICKFORD), 5 H. P., 1500 R. P. M., MOTOR

Running light	0.9
⅞ in. hole in cast steel	1.9

Feed—½ in. per min.
Speed of drill, 74 r.p.m.

5 FT. RADIAL DRILL (BICKFORD), 5 H.P., 1500 R.P.M. MOTOR

Load	Kilowatt Input	Speed of Drill
Running light	.48	
One ⅝ in. hole in steel, feed 0.45 in. per min.	1.3	52 r.p.m.
Two ½ in. hole in cast iron, feed 0.16 in. per min.	1.5	24 r.p.m.
Two ¾ in. hole in steel, feed 0.375 in. per min.	2.4	20 r.p.m.

51 IN. BORING MILL (BULLARD), 7½ H.P. MOTOR

Running light	1.8
Two ¼ in. cuts, 3/32 in. feed, 40 ft. per min. on cast iron	4.6

Tool steel—Mushet high speed.

47 IN. BORING MILL (BAUSH), 10 H.P. MOTOR

Running light	1.9
One 7/32 in. cut, 1/32 in feed, 35 ft. per min. cast steel	3.
One 3/16 in. cut, 3/64 in. feed, 40 ft. per min. cast steel	3.5
One 3/16 in. cut, 1/16 in. feed, 50 ft. per min. cast steel	4.

Tool steel—Mushet high speed.

BUFFER AND GRINDER (RAWSON), 3 H.P. MOTOR

Running light	0.4
Grinding 6 in. steam pipe to surface	0.5

COLD SAW (NEWTON), 3 H.P. MOTOR

Running light	.6
Cutting 6 in. cast iron	3.2

Slow feed, 0.45 in. per min.
Saw 16 in. diam., 14½ r.p.m.

FLUE CLEANER (RYERSON), 25 H.P. MOTOR

Rolling	7.2
Lifting	17.

Loaded with 308— 2 in. diam. tubes, 12 ft. long.

NO. 5 PUNCH (HILLES & JONES), 5 H.P. MOTOR

Running light	0.7	
Punching 9/16 in. hole in ¼ in. boiler plate	1.3	Max.
Punching 9/16 in. hole in 3/16 in. boiler plate	1.2	Max.
Punching 9/16 in. hole in 5/16 in. iron	1.5	Max.
Punching 9/16 in. hole in ½ in. steel	2.32	Max.

22 punches per min.

NO. 4 PUNCH (HILLES & JONES), 10 H.P. MOTOR

Running light	.5	
Punching 13/16 in. hole in ½ in. flange steel	4.	Max.

NO. 9 PUNCH AND SHEAR (HILLES & JONES), 15 H.P. MOTOR

Running light	3.	
Punching 2 in. hole in ¼ in. boiler plate	5.	Max.
Punching 2 in. hole in 1½ in. wrought iron	22.	Max.
Shearing 4 in. by 2½ in. hammered iron	10.	Max.

NO. 3 SHEAR (HILLES & JONES), 5 H.P. MOTOR

Running light	0.3	
Shearing round steel ½ in. diam	0.8	Max.
Shearing round steel ¾ in. diam	1.1	Max.
Shearing boiler plate ⅝ in. by 2½ in	2.	Max.
Shearing boiler plate ⅜ in. by 1½ in	1.2	Max.

SPLITTING SHEAR (LENOX MACHINE CO.), 7½ H.P. MOTOR

Running light	0.4
Cutting ¼ in. boiler plate	1.7

Cutting speed—7.2 ft. per min.

10 FT. BENDING ROLLS (HILLES & JONES), 10 H.P. MOTOR

Running light	1.2
Bending ½ in. boiler plate, average	2.8 Max. 4.4

Boiler plate was 6½ ft. wide and was bent to a radius of 30 in. in 5 rollings.
Rolling speed—5.6 ft. per min.

63 IN. BOSTON CUPOLA AND FORGE BLOWER, 30 H.P., FORM L INDUCTION MOTOR

This blower furnishes air for one flange fire, two flue fires, and a four burner Ferguson annealing furnace, made by the Railway Materials Co.

All full blast	13.8
Two flue fires only	9.5

NO. 7 BLOWER (STURTEVANT), BULLDOZER (AJAX), 35 H.P., 500 R.P.M. MOTOR

Blower furnishes air for 5 furnaces.

Blower with 3 furnaces operating	16.3
Blower and Bulldozer	28.3 Max.

Bulldozer was making 2-90 deg. bends on ¾ in. by 3 in. iron.

STURTEVANT BLOWER, 35 H.P. MOTOR

Blower furnishes air for one double furnace, four single furnaces and five double forges.

3 single furnaces at work 1 double furnace at work	17.6
3 single furnaces at work 1 double furnace at work 1 double forge full vent	18.6

BLOWER (BUFFALO), EXHAUSTER (BUFFALO), FOR 20 FORGES AND 2 FURNACES, 50 H.P., 500 R.P.M. FORM L INDUCTION MOTOR

11 forges and 2 furnaces in operation	21.5

NO. 3 SHEAR (HILLES & JONES), 10 H.P. MOTOR

Running light	1.
Shearing 1½ in. wrought iron	5.5 } Max.
Shearing 2¾ in. wrought iron	6. } Max.

5 FT. 6 IN. RADIAL DRILL (NILES, BEMENT & POND), 5 H.P. MOTOR

Running light	1.2
Drilling ¾ in. hole in steel, feed 0.67 in. per min	1.5
Drilling 2½ in. hole in steel, feed 0.075 in. per min	1.8

MILL SHOP NO. 1

SWING CUT-OFF SAW (ROGERS), 3 H.P. MOTOR

Running light	0.74
Cutting 2 in. by 12½ in. spruce	2.4

Size of saw—19 in.
Speed—2080 r.p.m.

SWING CUT-OFF SAW (ROGERS), 3 H.P. MOTOR

Running light	0.9
Cutting 5 in. by 8 in. hard pine	6. } Max.
Cutting 2 in. by 10 in. hard pine	5. } Max.

Size of saw—18 in.
Speed—1840.

RAIL SAW (NEWTON), 7½ H.P. MOTOR

Running light	0.56
Sawing 6 in. steel rail, average	1.6 Max. 2.4

Feed—0.21 in. per min.
28 in. saw, 5.15 r.p.m.

RAIL BENDER (WATSON & STILLMAN), 15 H.P. MOTOR

Running light	1.
Bending 79 lb. rail to 24 ft., 11¼ in. radius	8.

Speed of rail—100 ft. per min.

15 IN. SLOTTER (DILL), 5 H.P., 1500 R.P.M. MOTOR

Running light	0.4
One ⅜ in. cut, 1/64 in. feed on steel	0.9

Tool steel—Mushet high speed.
Strokes per minute—23.

ELEVATOR, 5 H.P. MOTOR

Motor running light	0.56
Elevator up with one man	Pump back on line
Elevator down with one man	4.2
Elevator up with 1400 lbs	1.2
Elevator down with 1400 lbs	2.2

24 IN. EXTRACTOR, 3 H.P. MOTOR

Extractor filled with oily waste	0.96—0.88

Speed of extractor—1080 r.p.m.

NO. 3 GAINER (WOOD), 10 H.P. FORM L INDUCTION MOTOR

Running light	2.4
½ in. by 1½ in. gain in hard pine	4.4
2 in. by 4½ in. gain in hard pine	7.2

NO. 2 FORGING MACHINE (AJAX), 10 H.P. FORM L INDUCTION MOTOR

Running light	1.6
Punching 5/16 in. hole in a 1 9/16 in. rivet	5.0 Max.

NO. 5 FORGING MACHINE (AJAX), 20 H.P. FORM L INDUCTION MOTOR

Running light	3.7
Loaded	16.1 Max.

Load consisted of gathering a 1⅞ in. hemispherical head on a 1⅛ in. rivet.

GROUP (GALLERY), 7½ H.P. MOTOR

Machines	Load	Kilowatt Input
1 Two spindle irregular moulder (Carey)	Running light	
1 39½ in. band saw (Carey)	Running	
1 Double saw table (Carey)	Running	7.

When test was made saw was ripping 2 in. pine and saw bench ripping 2 in. oak.

GROUP, 10 H.P. MOTOR

4 Flue cutters	2 Running light 2 Running	
1 Flue welder	Running	4.

GROUP, 10 H.P. MOTOR

1 28 in. Vertical drill (Blaisdell)	Running	
1 40 in. Vertical drill (Bement)	Running	
1 38 in. Vertical drill (Prentice)	Running	
2 34 in. Lathes (Putnam)	1 Running	
5 22½ in. Vertical drills (Barnes)	1 Running	6.2

GROUP, 15 H.P. MOTOR

3 24 in. Lathes (Reed)	2 Running	
1 40 in. Vertical drill (Bement)		
1 42 in. Boring mill (Bullard)	Running	
1 24 in. Shaper (Stockbridge)		
1 15 in. Slotter (Betts)		
1 18 in. Slotter (Putnam)	Running	
1 30 ton Arbor press (Chambersberg)		8.

GROUP, 15 H.P. MOTOR

2 30 in. by 8 ft. planers (Woodward & Powell)	2 Running	
1 26 in. by 10 ft. milling machine, planer type (Becker-Brainard)		
1 5 ft. radial Drill (Bickford)	Running	
2 No. 2 horizontal boring mills (Betts)	2 Running	
1 25 in. vertical drill (Barnes)		8.

GROUP (GALLERY), 15 H.P. MOTOR

1 24 in. lathe (Fitchburg)		
2 20 in. lathes (Schumacher)	1 Running	
4 18 in. lathes (Prentice)	2 Running	
5 18 in. lathes (Schumacher)		
4 2 ft. by 24 in. flat turret lathes (Warner & Swasey)	2 Running	
2 2 ft. by 24 in. flat turret lathes (Jones & Lampson)	1 Running	
1 40 in. vertical drill (Bement)		
1 25 in. vertical drill (Barnes)		
1 3 in. bolt cutter		
1 1½ in. bolt cutter (Acme)		
2 double bolt cutters (Acme)	2 Running	Av. 12.
1 double bolt cutter (Niles, Bement & Pond)	Running	Max. 24.

GROUP, 15 H.P. FORM L INDUCTION MOTOR

1 trip hammer (Bradley)	Running	
1 No. 2 emery grinder (Diamond Machine Co.)	Running	
2 40 in. vertical drills (Bement)	2 Running	
1 Grindstone		
1 hammer (Bradley)		
1 No. 2 shear (Hilles & Jones)		
1 1½ in. forging machine (Ajax)		
1 2 in. forging machine (Ajax)	Running	Av. 13.
1 3½ in. forging machine (Ajax)	Running	Max. 19.

GROUP, 25 H.P. MOTOR

2 30 in. boring mills (Bullard)	1 Running	
2 24 in. lathes (Reed)	2 Running	
2 18 in. lathes (Reed)		
1 24 in. turret lathe (Gisholt)	Running	
1 30 in. planer (Woodward & Powell)		
1 16 in. shaper (Gould & Eberhardt)		
1 24 in. shaper (Stockbridge)	Running	
1 16 in. shaper (Stockbridge)		
1 30 in. planer (Putnam)		
1 42 in. vertical milling machine (Hilles & Jones)		
1 double rod borer (Newton)		16.

GROUP, 30 H.P. FORM L INDUCTION MOTOR

1 No. 300 hollow mortiser (Wood)	Running	
1 No. 225 hollow mortiser (Greenlee)	Running	
1 30 in. single planer (Rogers)	Running	
1 30 in. single planer (Fay)	Running	Av. 22.2
Heavy load.		Max. 30.3

GROUP, 35 H.P., 500 R.P.M. MOTOR

2 irregular moulders (Wood)	2 Running	
1 60 in. three drum sander (Fay)	Running	
1 42 in. three drum sander (Fay)	Running	
2 grindstones	Running	
1 42 in. band saw (Fay)	Running	
2 turning lathes (Wood)		
1 dowel machine (Fay)		
1 rip saw	Running	
2 copper sheathing machines		26.3
Heavy load.		

GROUP, 40 H.P. FORM L INDUCTION MOTOR

1 No. 214 jointer (Invincible)		
1 Universal jointer (Fay)	Running	
1 saw table (Roolston Engine Works)		
1 end tenoner (Berry & Orton)		
1 5 spindle borer (Wood)	Running	
1 5 spindle borer (Greenlee)	Running	
1 self feed rip saw (Wood)		20.3

GROUP, 50 H.P., 500 R.P.M., FORM L INDUCTION MOTOR

1 chain mortiser (New Britain)		
1 buzz planer and drill (Fay)		
1 48 in. band saw (Fay)	Running	
1 10 in. outside moulder (Wood)	Running	
1 36 in. band saw (Atlantic)		
1 tenoner (Fay)		
1 double cabinet saw (Carey)		
1 tenoner		18.3

COMPUTER, COAST AND GEODETIC SURVEY.—An examination will be held September 7th and 8th to secure eligibles to fill a position of computer at a salary of $1,200. This examination will be on a basis of pure mathematics and practical computations only. These examinations are held in various places throughout the country, and anyone wishing to apply should write to the U. S. Civil Service Commission, Washington, D. C., for application form No. 1312. The age limit is 20 years or over on date of examination.

PASSENGER TRAVEL ON PENNSYLVANIA RAILROAD.—Figures compiled by the Pennsylvania Railroad system show that in 1908 and 1909 the various lines carried a total of 299,762,658 passengers over its 24,000 miles of track and only one passenger was killed as the result of a train wreck. These figures show that the chances of each passenger being killed in an accident is one in 300 million in two years and for each mile carried the chances are one in more than seven billion. During these two years but 370 passengers were injured in train wrecks.

THE NEW FACTORY OF THE TRIUMPH ELECTRIC CO.

The Triumph Electric Co. was founded in 1889, the original factory on Second street, Cincinnati, Ohio, occupying about 8,500 square feet of floor surface. In 1895 the company removed to large and more commodious premises at the corner of Sixth and Baymiller streets with an approximate floor area of 40,000 square feet, which was ultimately increased to about 65,000 square feet.

Notwithstanding the fact that these premises did not lend themselves readily to the adoption of improved methods of manufacture, the sales of the company steadily advanced, and in the six years between 1900 and 1906 were more than doubled. In 1908 these quarters were completely outgrown, and it became imperative that a new factory be built. Therefore, in 1909 8½ acres of land at Oakley, a subdivision of Cincinnati, were purchased, and on this site there has been erected a thoroughly equipped and entirely modern factory. This particular site was chosen on account of its unsurpassed shipping facilities, and because of the extent of property available for future extensions.

The main building of the factory is 300 ft. long by 140 feet wide, and three stories high. The center bay open to the saw-tooth type of roof, is spanned by a 25 ton traveling crane with a 5-ton auxiliary hoist. The second floor gallery on either side is devoted entirely to the stores department. The third floor east bay is occupied by the switchboard department, the coil winding, commutator departments, and the armature winding department. Each of these is located immediately above the stores where the raw material and finished products are kept, so that handling is reduced to a minimum. On the west bay similar conditions prevail. The third floor gallery is occupied by the small tool department immediately above the stores. Both the east and west bay are provided with two freight elevators, and in addition the third floor on either side can be served by the overhead traveling crane.

All heavy machine work is performed on the first floor, which is paved with concrete, making a solid foundation for the heavy tools, and is easily kept clean. On the east side are located the punch department and small testing departments, where both A C and D C motors of small size are tested before shipment. The larger machines are placed on a special floor made up of Z sections and concrete at the front end of the building in close proximity to the outgoing railroad switch, where they are erected and tested.

INTERIOR OF THE TRIUMPH ELECTRIC COMPANY'S NEW SHOP.

All modern conveniences in the way of clothes lockers and wash rooms are provided for the men and are located at the main factory entrance in the northwest corner of the building.

In addition to the main building another building 240 feet long by 60 feet wide is situated at the west rear end of the main building in such a position as to eventually form one of the ells, which have been provided for in the planned extensions. Here are housed the pipe department, the blacksmith shop and the brass foundry.

In conjunction with four other factories located in the immediate vicinity, a large power plant has been erected, which supplies light, heat, power and compressed air to the various factories at a nominal charge. This station is equipped with Triumph generators of 300 k. w. capacity, each direct connected to Hamilton-Corliss-Cross compound engines, and orders have now been booked for an additional 600 k. w. unit.

The available floor area of the new shops is at least three times as great as formerly, and about $50,000 worth of new equipment has been purchased in order to take care of the increased business of the company. Of especial interest is a new machine built by the Morton Co. of Muskegon, Mich., which materially reduced the time required to machine large castings, and is the first of its kind to be installed in Cincinnati.

Every indication points to the fact that the present buildings, although three times as large as formerly, will not be adequate to house the business of the company in the near future, and it has already been decided to lengthen the main shop by 500 feet and to build six ells, each 240 feet long by 60 feet wide, at right angles to the main building on the west side. These additions will be commenced just as soon as the volume of business demands. In addition, a separate administration building will be erected in order to allow room for the expansion of the testing department, and a new pattern shop has already been considered.

Poor's Manual of Industries.—The first annual number of Poor's Manual of Industries, containing 2,317 pages of text and designed to perform a work similar to that of Poor's Manual of Railroads, is being issued. This book is remarkable not only for its scope, which is much greater than has heretofore been attempted, but also for the aggregate industrial figures presented in the introduction. The total capitalization of all industrial corporations reported is $18,873,000,000. The total capitalization of all railroads in the United States, according to the Manual of Railroads, is $17,234,000,000. The average rate of interest on bonds of industrial corporation is 5.27 per cent., as against 3.88 per cent. on railroad bonds. The average dividend rate on industrial stock is 4.02 per cent., as against 3.5 per cent. on railroad stock.

Individual Drive for Small Tools.—Considerable difference of opinion has developed as to the advantages of individual versus group drives for machine tools, and while it is generally agreed that it is advantageous to have the larger tools individually driven, the agreement by no means extends to the smaller ones. Under certain conditions there is no question as to the advantages of the individual drive for small tools, as, for instance, where small tools are necessarily placed among larger ones, or to allow convenient placing of tools in the assembling departments. The cases where it would be advantageous to have small individually-driven tools are numerous.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

RECORD OUTPUT OF A CAR WHEEL LATHE

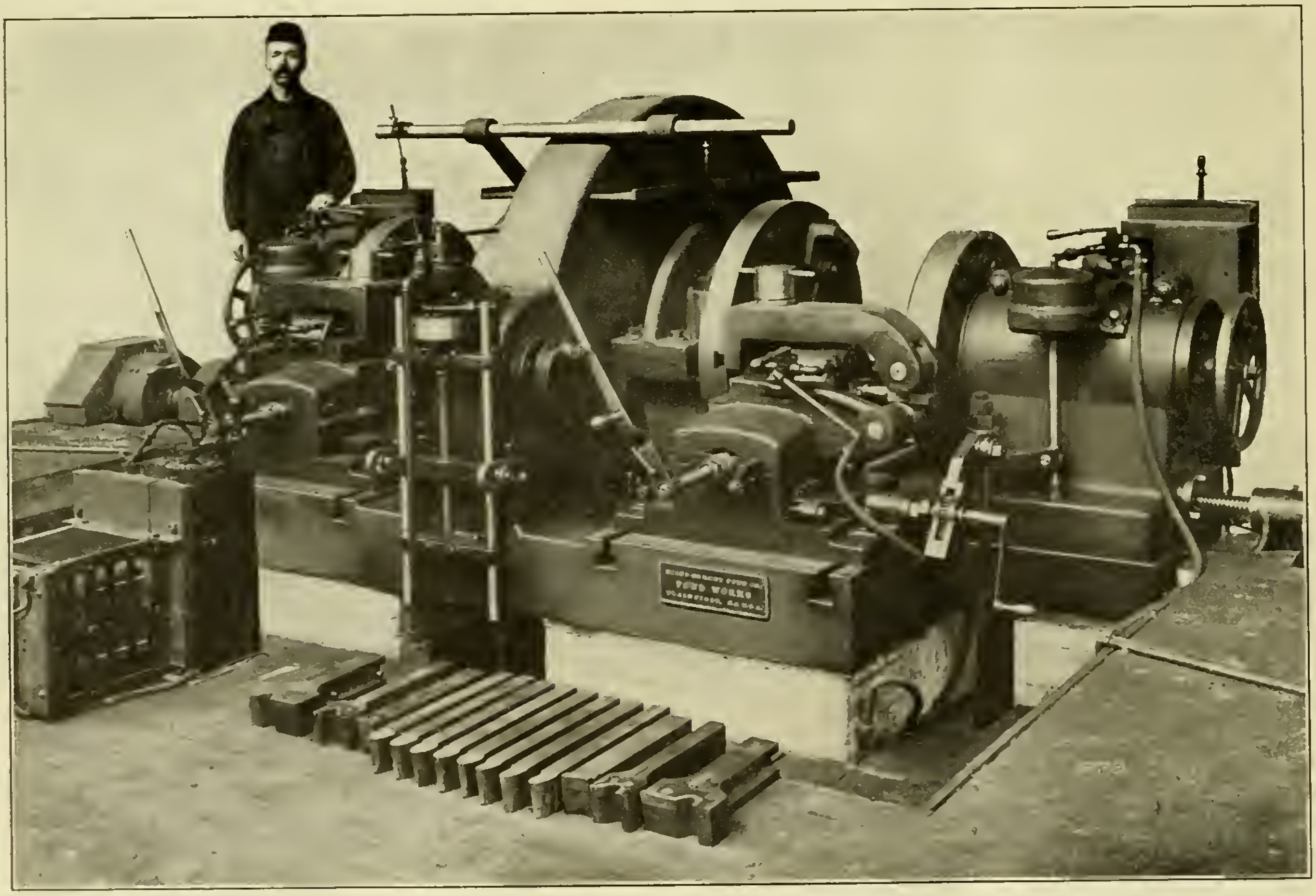
33 PAIRS IN 9 HRS. 53 MIN.

Recent improvements in the Pond 42-inch car wheel lathe have increased its speed of operation to a point where 33 pairs of 36-inch steel-tired wheels can be turned in less than 10 hours. In fact, this was recently accomplished at the West Albany shops of the New York Central by the workman who customarily operates the machine. The details of this day's work are given in the table on the next page.

Pneumatic devices and attachments of various kinds on the lathe are largely responsible for this record. These consist of a pneumatically operated tool post, air cylinders for moving the tail stock, air operated clamps for holding the tail stock in place and skids raised by air cylinders to bring the axle up to the centers. Automatic operation of the gear segment also assisted materially in increasing the speed of operation. All valves for operating the various air appliances are conveniently located within reach of the operator's platform.

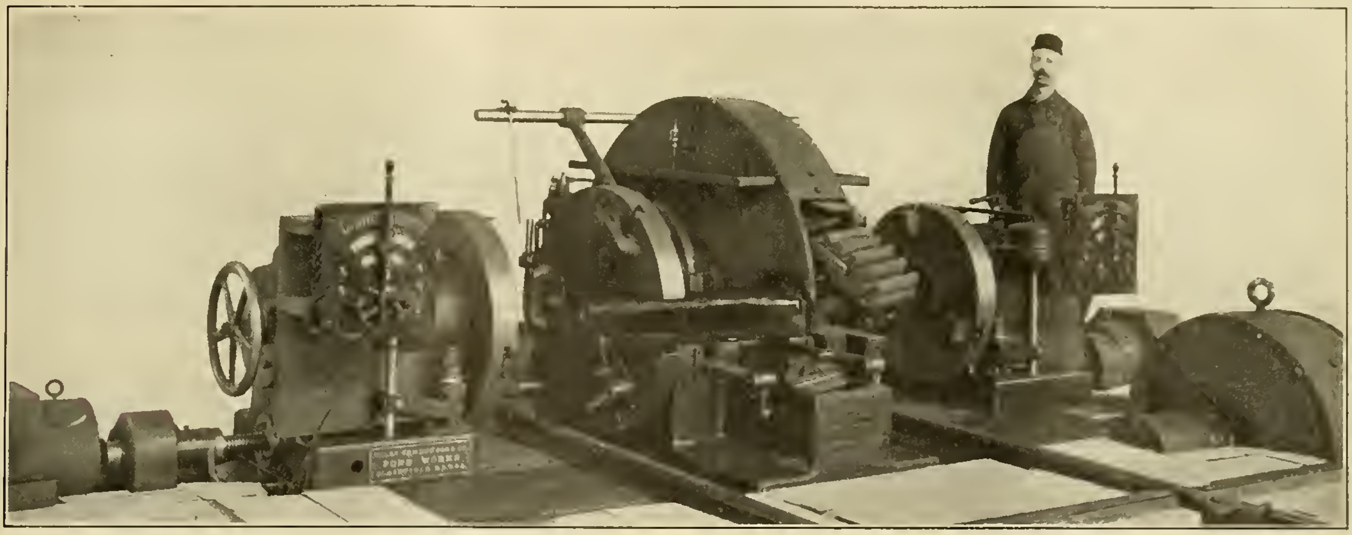
The new power tool seat will clamp the largest tools rigidly and instantaneously. The air cylinder which furnishes the power for clamping the tool is a part of the lower member of the tool rest. The piston working in the cylinder forces a wadge between a lower fixed roller and an upper roller on the lever end of the clamp itself. The strain on the tool incident to the cut is not carried back to the elastic medium in the cylinder. When the rollers are forced apart by the piston wedge, they remain in that position whether the pressure is maintained in the cylinder or not; thus making the clamp a positive lock. The rest is entirely open at the side and the tools are readily changed without any movement to the slide; in fact, with no extra manipulation of any kind. The power cylinder, being part of the tool rest, offers no obstruction to the view of the work.

The lateral pressure on the wheels, as a result of taking heavy roughing cuts, tends to cause the tailstocks to slide on the bed, necessitating the use of four heavy T-bolts to hold each tailstock in position after it has been adjusted. The time and labor incident to tightening and loosening these T bolts has been reduced to a negligible quantity through the use of pneumatic pistons on each tailstock. The downward thrust of the piston operates powerful levers on either side of the tailstock, the rocking movement of which draw up the heavy sliding T bolts and hold the tailstock securely in position.



POND 42-INCH CAR WHEEL LATHE WITH NEW ATTACHMENTS THAT HAVE GREATLY INCREASED ITS OUTPUT.

Improvised skids have heretofore been used to lift the axle to the position where the tailstocks could run to the centers. The wheels are now run into the machine on two light rails which extend to the center of the lathe; two pistons, operated by power and underneath the ends of the rails, raise the wheels with their axle to the centers of the face plates. They can be raised and lowered quickly and accurately by the simple movement of a valve. The rails are specially constructed to be as light as possible and are movable so that they will not interfere when cleaning out the chips.



VIEW SHOWING AUTOMATIC OPERATION OF THE GEAR SEGMENT.

The gear segment is automatically left in an open position when the wheels are rolled out of the lathe. The axle of the next pair of wheels, when it is rolled in, strikes a projection on the underside of the segment, tripping a latch, held in position by a spring, and forces the segment to drop into place. A heavy latch holds the segment in its working position until it is again released by the axle when the wheels are taken out. This not only greatly reduces the time required for putting the gear segment in and out of place, but eliminates all manual labor on the part of the operator.

On May 11, 1910, one of these lathes at West Albany was working on 36-inch Krupp and Paige steel-tired wheels and a careful and detailed record of its operation was obtained and is reproduced in the accompanying table. The net result was 33 pairs in 9 hrs. 53 min., or an average of less than 18 min. per pair from floor to floor.

Pair No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Average
Putting in lathe	3	2	2	3	2	2	2	3	2	3	2	2	4	2	2	2	4	3	2	2	3	3	2	3	2	2	3	3	3	3	3	1	1	2 min. 28 sec.
Roughing	11	8	9	9	9	9	9	9	11	10	10	9	11	12	8	9	8	10	8	9	9	11	9	11	9	10	7	10	9	10	10	7	10	9 min. 23 sec.
Finishing	5	6	4	3	5	4	6	4	7	5	5	5	5	8	4	5	4	6	7	5	5	6	5	6	5	6	5	6	5	4	3	5	5	5 min. 7 sec.
Taking out	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1 min. 0 sec.
Time from floor to floor	20	17	16	16	17	16	18	17	21	19	18	17	21	23	15	17	17	20	18	17	18	21	17	21	17	19	16	20	18	18	17	14	17	17 min. 58 sec.
Depth of cut	1/4	1/8	3/16	1/4	3/16	1/8	1/8	3/16	3/16	1/4	3/16	1/8	3/16	1/2	1/8	3/16	3/16	1/8	1/4	1/4	1/4	3/16	3/16	1/4	3/16	1/8	1/8	3/16	1/4	3/16	3/16	1/8	3/16	1/4	3/16 inch
Feed	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	5/16	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32 inch
Speed	16	16	17	15	14	12	13	18	12	14	15	15	13	10	14	12	15	11	12	10	14	12	14	13	11	14	20	15	17	17	16	21	18	14 4 feet

WHAT A POND 42-INCH CAR WHEEL LATHE DID IN ONE DAY.

Firing Up Locomotives.—In computing the expense of firing up locomotives the steam used for blower purposes should be taken into account, and it has been demonstrated that less blowing is required with oil and shavings than with wood or with the oil atomizer, this due to the coal igniting uniformly over the grates. A number of tests have been made demonstrating that the volume of coal required to build a fire from wood is equal to that where oil and shavings are made use of, it being evident that the heat units obtained from the combustion of the wood are practically lost, this due to the fact that large volumes of cold air pass through the grates as the result of uneven ignition. It is the opinion of the committee that except in the case of very light lines operating in the territory where wood is plentiful and where the number of locomotives handled is not sufficient to justify the installation for the use of oil and shavings, the use of wood should be abandoned.—*From committee report International Ry. Fuel Ass'n.*

Handling Scrap.—I wish to call your attention to the importance of handling scrap and the care which should be taken of it to give the best results from a financial standpoint, for the revenue on this alone amounts to thousands and thousands of dollars and goes a long way towards defraying the expenses generally. You will invariably see that the trunk lines, with the assistance of officials and subordinates who take a great interest in the scrap bins, very seldom go into the hands of receivers. The sorting of scrap is the most important, for the price per ton on all grades varies from 25 cents to $5.00. When the general storekeeper turns cars over to the transportation department for weighing, collection and sight drafts he should have a record of the car. In fact all scrap contracts should be handled through the store department and all collections made by it with the approval of the purchasing agent. That is, it should be taken out of the hands of the freight department entirely, except for billing, to get the best results.—*George Westall before the General Storekeepers' Assn.*

VANADIUM CAST IRON FOR LOCOMOTIVE CYLINDER.*

Cast iron may be regarded as a more or less impure steel, containing, in addition to the usual elements present in steel, a comparatively large quantity of carbon in the form of graphite interspersed throughout its structure in the form of granules, flecks or plates. The graphite destroys the continuity of the metal. In consequence the limit of strength of cast iron is low as compared with steel, and it also follows that any improvement conferred upon cast iron by an alloy must necessarily not be as great as in the case of more homogeneous steel. In cast iron, also, we have a metal that is subjected to no work or heat treatment to develop latent qualities.

Nevertheless the benefits which accrue from the incorporation of small percentages of vanadium with cast iron, especially in chill and cylinder castings, are very great, even if they are not so spectacular in their nature as those obtained in steel. Vanadium not only cleanses the cast iron from oxides and nitrides, but also exercises a very strong fining effect on the grain of the iron, with the result that porosity is eliminated and sound castings are produced. Strength, resistance to wear and rigidity are all increased by the addition of vanadium to gray cast iron, while the vanadium martensites are much tougher than ordinary martensites. In the case of chilled cast iron, vanadium produces a deeper, stronger chill, and one less liable to spall or flake. Chilled iron rolls containing vanadium have shown remarkably increased resistance to wear in service.

As a result of two years' test on a pair of cast iron cylinders made of vanadium cast iron, the New York Central Railroad Company specified vanadium cast iron for the cylinders of 183 new locomotives built during the past eight months. The pair of cylinders under test gave upward of 200,000 miles, with only microscopical wear, whereas ordinary locomotive cylinders will show about 1-32 in. wear per 100,000 miles. These locomotives were built by the American Locomotive Company and comparative tests have been made between the iron containing vanadium and that to which no vanadium was added. The averages of 10 consecutive comparative tests are as follows:

	Transverse strength. Pounds.	Tensile strength. Pounds.
Plain cast iron	2,130	24,225
Vanadium cast iron	2,318	28,728

The transverse tests were made on 1-in. square bars, 12 in. between supports; the bars were machined all over and consequently were absolutely comparable, as is not the case with bars tested as they are cast. The tensile tests were also of machined bars. In machining the vanadium cast iron cylinders, the effect of the vanadium was noticed in the machining qualities of the iron; the chips were not so short, were tougher and showed considerable springiness.

The use of vanadium in cast iron will doubtless find its greatest field in engine cylinders, both gas and steam, where it will be of great value in increasing the life of the cylinder through its effect on the wearing qualities of the iron.

Tests of vanadium in malleable cast iron have been reported as satisfactory in every way, the fibre of the iron showing much cleaner and the tensile strength being improved about 12 per cent. The castings were also very much stiffer than ordinary malleable castings.

In applying vanadium to cast iron, it must be remembered that nothing like the heat of molten steel is at hand; consequently one should use a finely crushed or powdered alloy of a low melting point. As the melting point depends directly upon the percentage of vanadium contained in the alloy, a ferrovanadium containing under 35 per cent. vanadium should be used. If the iron to be vanadized is melted in the air furnace, the procedure is a very simple one: after the charge is melted and 15 to 20 minutes before tapping, the ferrovanadium is added and the bath well stirred or rabbled.

Where the iron is melted in the cupola it is necessary to add the vanadium to the ladle, and, as the amount of heat available for dissolving the ferrovanadium is limited,, the iron should be tapped out as hot as possible and a ladle used that has just been emptied in order to conserve as much heat as is practicable. After the bottom of the ladle is covered with a few inches of iron, the finely crushed or powdered ferrovanadium is added by sprinkling it on the stream of iron as it flows down the spout to the ladle. In this way advantage is taken of all the available heat, and there is also the mixing effect of the stream as it strikes the iron in the ladle. After the vanadium is added the contents of the ladle should be well rabbled and allowed to stand a few moments before pouring in order to insure thorough incorporation and complete reaction.

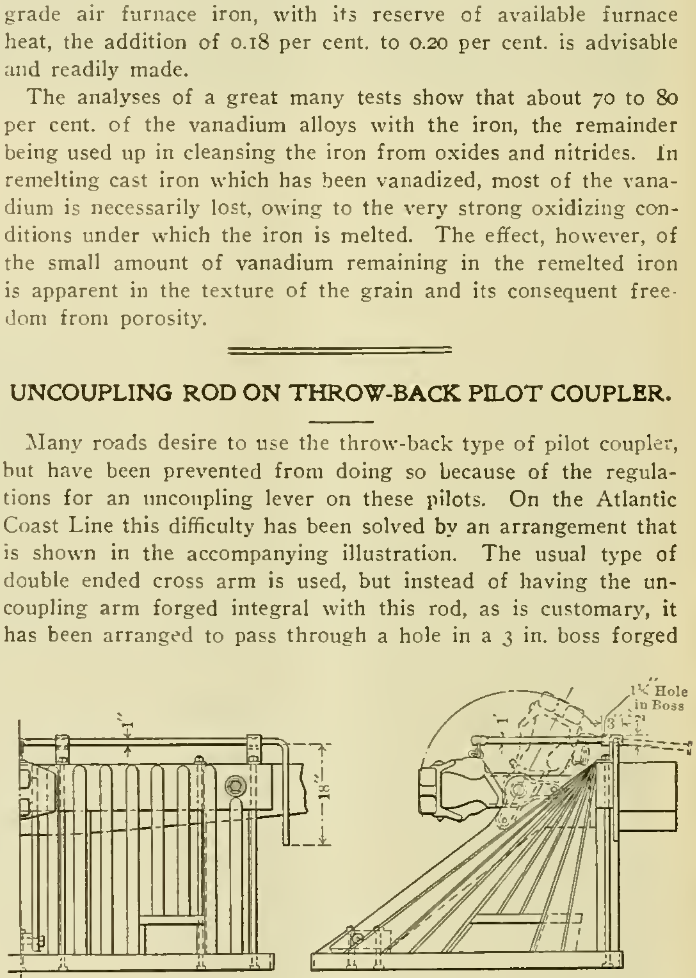
In the case of cupola iron, with its limited available heat, it has been found that the addition of 0.10 to 0.12 per cent. vanadium is all that should be attempted ordinarily; while in the case of high grade air furnace iron, with its reserve of available furnace heat, the addition of 0.18 per cent. to 0.20 per cent. is advisable and readily made.

The analyses of a great many tests show that about 70 to 80 per cent. of the vanadium alloys with the iron, the remainder being used up in cleansing the iron from oxides and nitrides. In remelting cast iron which has been vanadized, most of the vanadium is necessarily lost, owing to the very strong oxidizing conditions under which the iron is melted. The effect, however, of the small amount of vanadium remaining in the remelted iron is apparent in the texture of the grain and its consequent freedom from porosity.

* Extracts from a paper read at the May meeting of the New England Foundrymen's Association, at Hartford, Mass., by Geo. L. Norris.

UNCOUPLING ROD ON THROW-BACK PILOT COUPLER.

Many roads desire to use the throw-back type of pilot coupler, but have been prevented from doing so because of the regulations for an uncoupling lever on these pilots. On the Atlantic Coast Line this difficulty has been solved by an arrangement that is shown in the accompanying illustration. The usual type of double ended cross arm is used, but instead of having the uncoupling arm forged integral with this rod, as is customary, it has been arranged to pass through a hole in a 3 in. boss forged



on the cross rod. This is sufficient to give the necessary stiffness and permits the arm to slide back through the cross rod when the coupler is thrown back. This arrangement has been used for some time on this road and has met with the approval of the Interstate Commerce Commission.

On the pilot illustrated, in this connection, it will be noted that the bars have been cut away at the bottom to provide a step for the trainmen without the application of extension on the pilot base.

STANDARD LOCATION FOR CAR DOOR FASTENERS.—In my opinion, the Master Car Builders' Association should prescribe a standard height from the top of rail for placing door fastenings on all new cars built and when repairing old cars requiring new doors, or door stops, the door fastenings should be placed at the new standard. If this is done it will only be a very few years until car door fastenings will practically all be of a standard, and seal records all over the country raised to a higher standard of accuracy.—*Mr. Levy, before the Association of Transportation and Car Accounting Officers.*

NEW HORIZONTAL UNIVERSAL TOOL.

Machine shop people for some time have been in need of a tool at reasonable cost for machining the heavier class of very bulky castings which would be capable of performing a number of different operations with one setting of the work. With a view to meeting this demand especially for work on large locomotive castings requiring a large amount of time and labor for handling, such a machine has been designed and placed on the market by the Fosdick Machine Tool Co., of Cincinnati, Ohio.

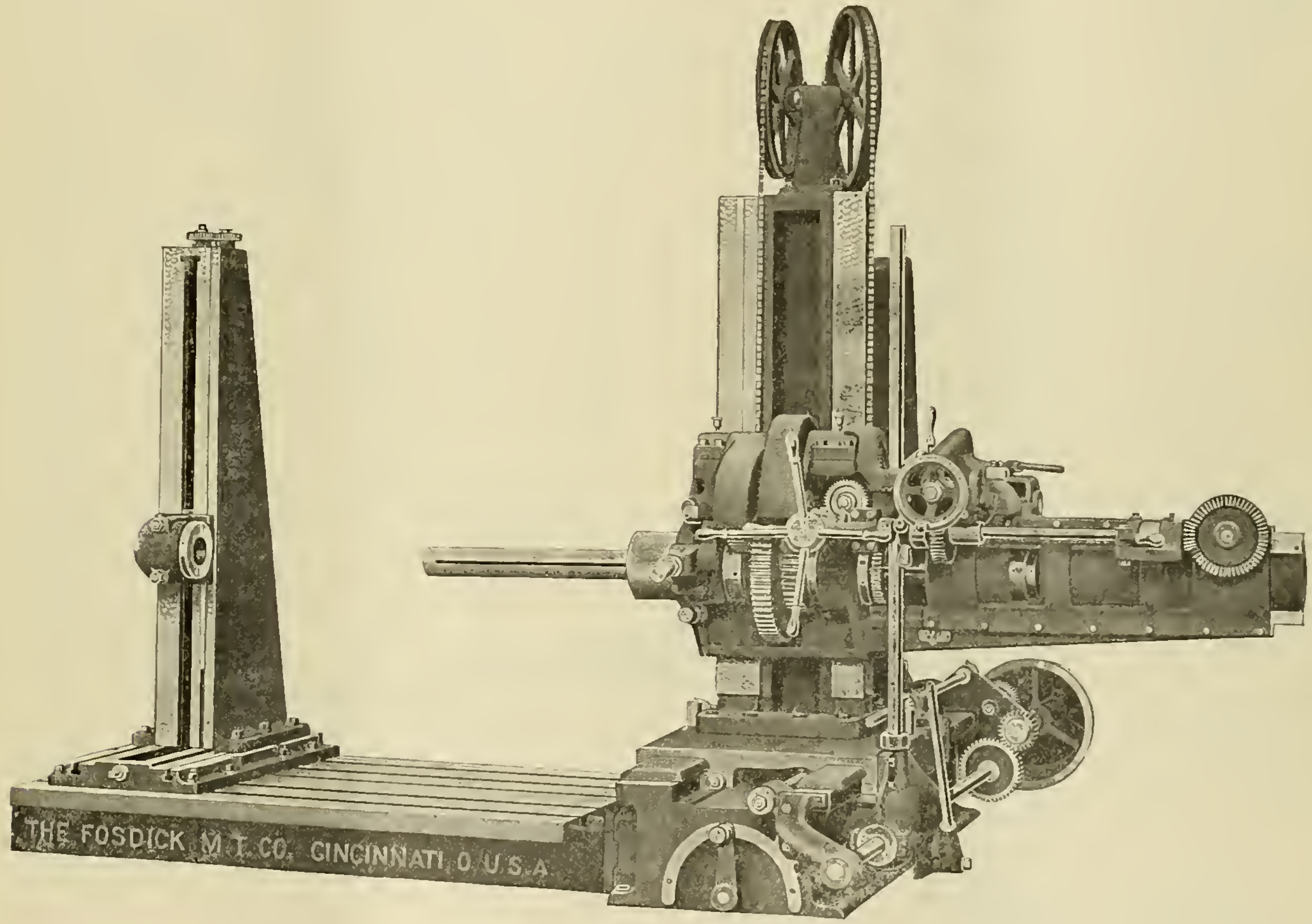
The accompanying illustration shows the new tool, known as No. 1, style D machine, combining the characteristics of a horizontal boring, drilling, milling and tapping machine. The bed plate and work table is very low so that the work of placing heavy castings is reduced to a minimum. The boring bar support at the left is designed specially for rigidity with broad square bearings at its base for the horizontal traverse, and also at its side for the bronze bushed tail bearing. Vertically, the traverse of the tail bearing on the bar support is simultaneous with that of the counterbalanced head on the column which is accomplished either by hand or power, so that the boring bar is always in perfect alignment. This is an essential feature in a well designed machine even when the boring bar itself is made of large diameter to withstand heavy strains.

The machine was designed throughout for the use of very high speed tool steels. With this high speed work in view the spindles are forged from the best quality of steel with liberally large diameters. All the gears are cut from steel with a large pitch and the journals are bronze bushed. The back gears and feed gears, as well as all the operating levers are located on the head, making a convenient and compact arrangement.

The column has very large bearing surfaces at its base for longitudinal traverse, reducing the wear at this point as much as possible, and the defects due to lost motion often found in a boring machine are practically eliminated. The general design of the column provides ample strength and rigidity to insure accurate work.

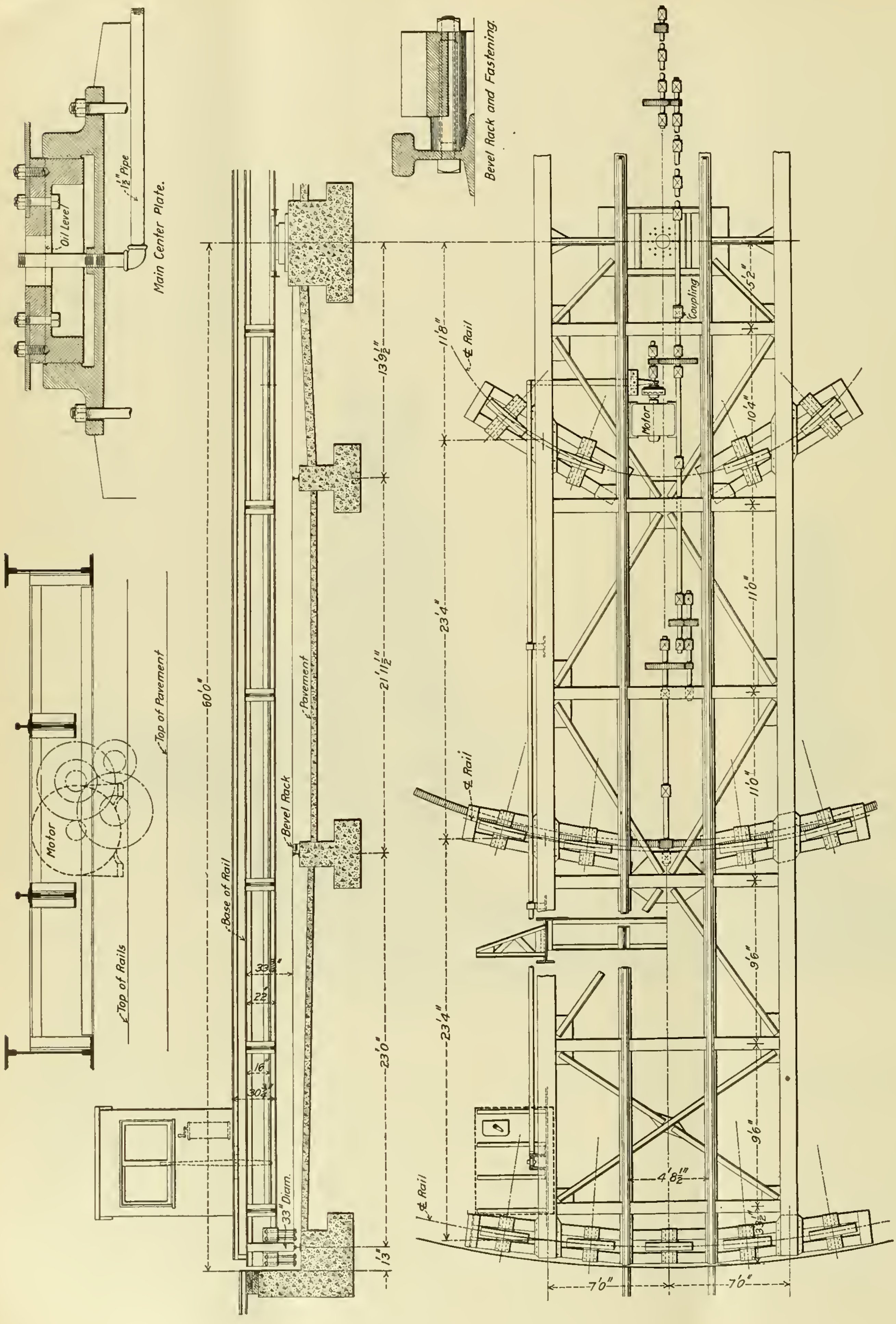
Power is transmitted either through a cone pulley or a speed box and may be supplied by a variable speed or constant speed motor mounted on the base if so desired.

These machines are built in two sizes, No. 1 and No. 2, and in four different styles. The style A machine is provided with a high work table and boring bar support. Style B is designed and generally used as a portable machine, there being no work table and boring bar support. Style C is the machine without a work table, but it is furnished with a special bar support usually mounted on the floor plate, and the style D machine is provided with a low work table, as illustrated. The latter tool is often furnished with a universal, rotating and tilting table by the use of which it is possible to drill, tap, bore or mill a large casting on five sides without resetting the work.



FOSDICK NEW HORIZONTAL BORING, DRILLING, MILLING AND TAPPING MACHINE.

P. R. R. Passenger Car Yard at Philadelphia.—To eliminate congestion on its tracks between Broad Street Station and West Philadelphia, the Pennsylvania Railroad is enlarging its elevated railroad between these two points and building a passenger car storage yard east of the Schuylkill River. As the present car yard is a mile away from Broad Street Station, it has been found difficult to handle the shifting of trains necessary to haul some 21,000,000 people—the number arriving and departing in 1909 on 194,368 trains. The new car yard between 20th and 23rd streets will accommodate sixty cars, or about nine suburban trains, and will be equipped with a 70-foot turn-table, which will eliminate the sending of all locomotives to the West Philadelphia yard for turning. To complete the yard will necessitate the building of retaining walls and embankments, the extension of the arch bridges over 21st and 22nd streets, and the construction of two new bridges across the Schuylkill river. It is expected that the entire work will be completed by December 1st at a cost of approximately $750,000.



NEW TYPE OF TURNTABLE ESPECIALLY DESIGNED FOR THE HEAVIEST TYPES OF MALLET COMPOUND LOCOMOTIVES.

NEW LOCOMOTIVE TURNTABLE.

The extensive introduction of Mallet compound locomotives into American railway service in the past few years has been the cause of much serious consideration of the facilities for housing and turning such locomotives at terminals. With this in view, a patent has recently been applied for by Frank H. Adams, engineer shop extension of the Santa Fe at Topeka, Kansas, covering an interesting and special design of motor driven turntable for this large class of power, thus solving one of the annoying problems of turning without disconnecting the tenders from the locomotives.

It is well known that railroads for years have turned their locomotives and rolling stock on turntables centrally supported and having end supports to temporarily take the load while the locomotive or car is being moved to a balanced position on the turntable, the latter being revolved either by hand through the means of extended levers at each end, or by means of a pneumatic or electric motor mounted on a platform hinged from the main turntable structure driving a wheel in frictional contact with a circular tee rail near the outer circumference on the bottom of the pit. The tractive force of this wheel due to the weight of the hinged platform, motor and mechanism was usually sufficient to revolve the turntable when the load was balanced and all in good working order. But the size and weight of railroad locomotives and rolling stock have been increasing rapidly during the past few years, until some locomotives with their tenders represent a combined weight in working order of about 350 tons and an extreme length over all of about 110 feet. It is desirable to turn these longer locomotives with their tenders without disconnecting the latter, and yet a length of 85 to 90 feet seems about the limit from an economical, practical, and operating standpoint for building the present type of centrally supported table and keeping within a reasonable expenditure.

It is therefore important that suitable means be provided for turning this heavier and longer power by providing a turntable longer and proportionately at a less cost than that of the present type tables and one provided with a simple and positive driving device. A new table which embodies in its design these features is shown in the illustration. The load instead of being almost entirely supported on the center bearing and foundation is more evenly distributed by providing three circular tracks and their foundations, located at approximately equal spaces between the center and outer edge of the pit. For this reason the foundation at the center is comparatively light and the usual massive center casting is eliminated. The small center plates shown in section are not intended to sustain any part of the load, their function being simply to aid in maintaining the table in a central position and to provide a place for introducing the electric wire conduit.

The usual style of built-up plate girders, braced transversely and diagonally, are used in the construction of the table and uniform support is provided by five 33 in. cast iron wheels at each end and four similar wheels on each of the two intermediate tracks. The electric motor is located in the first panel near the center plates and the shafting with two pairs of reduction gears is extended on each side of the center to a pinion at the circular rack which is fastened on the same foundation with the outer intermediate track as shown in the small sectional view. The pinion engaged by the rack is 11 in. in diameter by 5 in. wide and is intended to run at 45 r. p. m. There is an operator's cab supported in the usual manner near one end of the table.

Power is transmitted through a friction coupling near the motor, which is operated by means of a rod to the cab. To revolve the table the motor is started to allow full speed under no load before shifting the coupling into contact and thus transmitting the power to the rack pinions.

BALATA BELTING PLANT.

In October, 1909 (page 416), this journal contained an article giving a complete description of Balata textile belting with facts concerning its manufacture, characteristics and application, and it is a well-known fact that a well made balata belt gives the best results where severe service is required. This belting is at present used extensively by many railroads as an axle generator belt for car lighting purposes, because it is thoroughly waterproof. It is also used largely for operating wood working machinery, for motor drives and on fine tooling machines.

Although an enormous quantity of Balata belting is in service in this country at the present time for transmission purposes, every foot of it has been manufactured in Germany or England and imported. The announcement, therefore, that a syndicate has been formed to introduce this new manufacturing interest into the United States will be of considerable interest, especially to present owners of the belting.

A corporation, to be known as the Victor-Balata and Textile Belting Co., has been formed combining American interests with those of the German firm of C. Vollrath and Son, which is the largest firm of textile belting manufacturers on the European continent. The New York Leather Belting Co., representing the American interests of the new enterprise, were pioneers in first introducing Balata belting in the American market.

The factory site, covering nine acres of ground, is located at Easton, Pa., and the buildings and equipment for the new plant will entail an expenditure of half a million dollars. An interesting feature in connection with the new plant is the complete small village to be erected on the site to house the large number of workmen and the large weaving plant for the cotton duck.

The officers of the new company are: Chas. E. Aaron, of New York, president; Edwin Vollrath, of Blankenburgh, Germany, secretary, and John R. Stein, New York, treasurer.

STEAM AND ELECTRIC RAILWAYS.

Those who are doubtful of the future of electric railways or their relative progress should recall that the first steam railway in the United States was the Balitmore & Ohio on which construction was started in 1828 and which was opened to service in 1853. The first operating electric railway in this country was an experimental line at the laboratory of Thomas Edison at Menlo Park which was built in 1880. The first regular electric railway in the United States was one operated on Hampden Road, Baltimore, in 1886. The electric railways now carry more passengers annually than the steam railroads, with gross receipts amounting to less than one-sixth of those of the steam roads and with only an eighth of the mileage of the steam railroads.

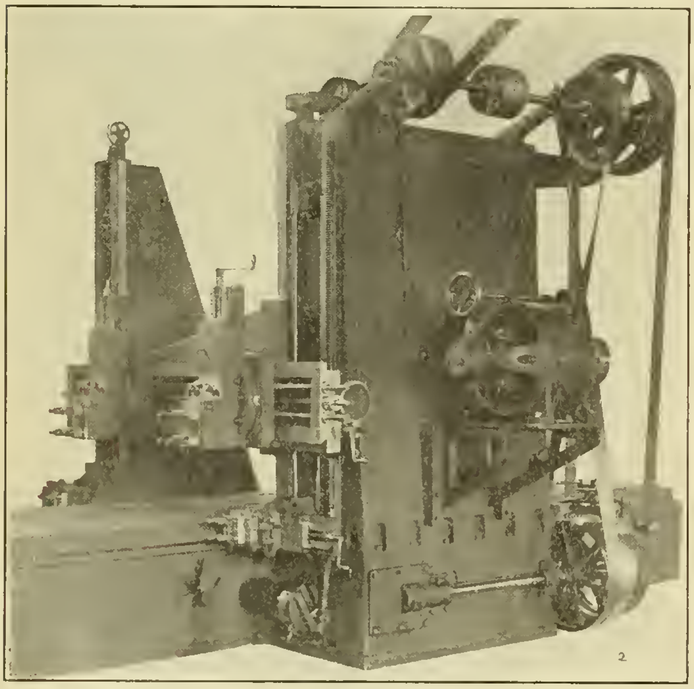
SELECTING MOTORS FOR MACHINE TOOL DRIVE.—One of the most important features in the selection of motors and one that is persistently overlooked, is the strict adherence to the use of standard motors, and by standard motors is meant standard armature shafts as well. The importance of maintaining standard armature shafts will be readily recognized by the factory management when it is pointed out that by such an arrangement spare armatures are reduced to a minimum, and that in an emergency it is possible, where these are not carried, to replace an armature or even a whole motor, from an idle tool, or from a tool of relatively less importance at the time. Also, of course, stock motors can be supplied promptly by the manufacturer and shipments materially improved if special shaft extensions are not called for. That special features in a motor are sometimes desirable, is not to be denied; it may so happen that the advantages from some special feature in the motor may more than offset the disadvantages above referred to, but in cases where these features are thought necessary they should be carefully considered before final decision.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

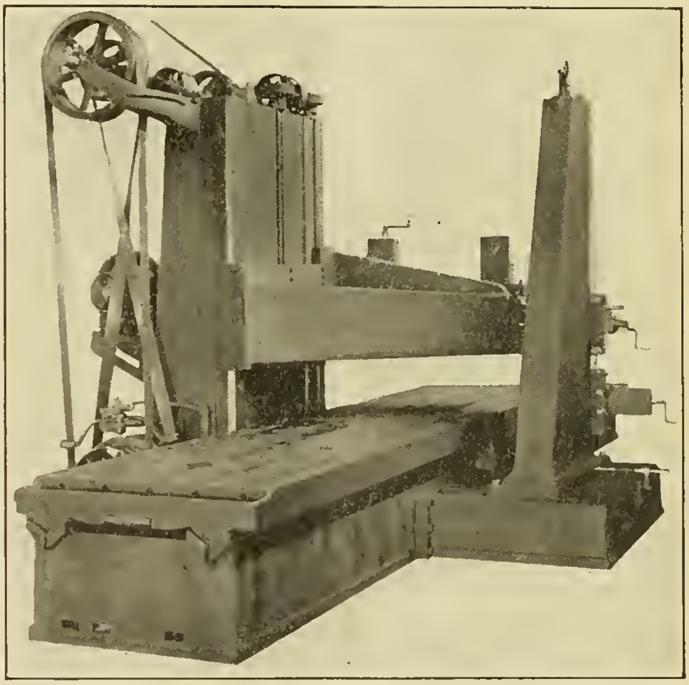
OPEN SIDE PLANER.

On some classes of work an open side planer is a necessity, on others it is a great convenience, and with the design illustrated herewith it is as valuable for nearly all kinds of work as the regular type.

This machine, as will be readily appreciated from the illustrations, is of exceptional rigidity and very conveniently arranged. It is designed so that four tool heads can be used and has all of the usual automatic feeds found on a four-headed planer. It is designed to take any cut which the tool will stand and is guaranteed for both accuracy and amount of cut to be equal to the same size machine of the usual type.

In construction the bed is cast closed on top and has solid cross ribs at frequent intervals, making it in fact a series of boxes. The column is cast solid with the bed up to the table level, at which point the upper section is securely bolted and doweled, resting on broad flanges. The table itself is of ample depth and is provided with T slots and holes at frequent intervals, none of the latter being bored through the table.





CLEVELAND OPEN SIDE PLANER, SHOWING ITS GREAT RIGIDITY AND STRENGTH.

Reference to the illustration showing the rear of the machine clearly indicates the exceptionally broad and stiff bearing which the cross rail has on the column. In this connection it might be mentioned that the outside column is employed entirely to give a fourth tool head and does not in any way support or stiffen the cross rail. This column can be quickly removed when the planer is to be used for open side work. The heads are arranged to be operated from either side of the machine and have automatic feeds in all directions.

All of the minor features throughout the whole machine have been given very careful study and many improvements here and there will be discovered. The belt shipping device is remarkably simple. All gears, except the bull gear and its pinion, are arranged to run in oil; the bearings are of phosphor bronze, pressed in so that they can be easily removed at any time without disturbing the alignment. It is further arranged so that all gearing and running parts can be removed through the sides of the machine, thus obviating taking down any heavy parts in case anything should need attention. The machine is arranged to be operated entirely above the floor level, making a special foundation unnecessary. It is suited for either electric or belt drive, the motor shown in the illustration being 25 h.p. variable speed.

The machine shown in the illustration is size 60 by 84 in. by 22 ft., and has an approximate weight of 94,000 lbs. This and other sizes of open side planers of the same general design are manufactured by the Cleveland Planer Works, 3148 Superior avenue, N. E., Cleveland, O.

A Year's Clean Record Rewarded on the Lehigh Valley.—For several years the Lehigh Valley Railroad has punished minor infractions of its rules by what is known as "record suspension," which means that instead of a man being actually laid off for 30 or 60 days he continue at work, and this amount of punishment is entered against his record and stands the same as if he was out of service for that length of time. These records, of course, are taken into consideration when an employee is considered for promotion or is being disciplined for some other violation of rules. This system is found to be thoroughly satisfactory, and it has now been deemed advisable to further revise it. And beginning July 1, 1910, employees with imperfect records will have an opportunity to clear them by loyal and efficient service in the future. By this method employees having a clear record for two years prior to July 1 will be entitled to cancellation of all demerits previously incurred. A clear record for one year will cancel all demerits prior to 1905, and a clear record for twelve consecutive months at any time after July 1 will cancel demerit records up to that date. Ten days will be cancelled by a clear record of six months; 30 days by a clear record of 12 months, and 60 days by a clear record of 18 months after July 1. When an employee's demerit record aggregates 90 days he is relieved from duty and is also to be summarily dismissed for drunkenness, carelessness, insubordination, etc.

Employees Given Automobile Tours.—Wells Brothers Company, of Greenfield, Mass., has been sending the foremen of the various departments of the factory and their families on outings during the summer months. These outings take the form of all-day automobile trips through the surrounding countryside and to the nearby cities and towns. One or two of the foremen, with their families, are sent at each time, the company providing a big touring car and paying all expenses. Each trip is about 125 miles long, the start being made early in the morning, and the return ride early in the evening. Dinner is arranged for at one of the hotels at the point of destination. These trips are all to different places and all have proved very enjoyable.

COLD SAW CUTTING OFF MACHINE FOR BARS.

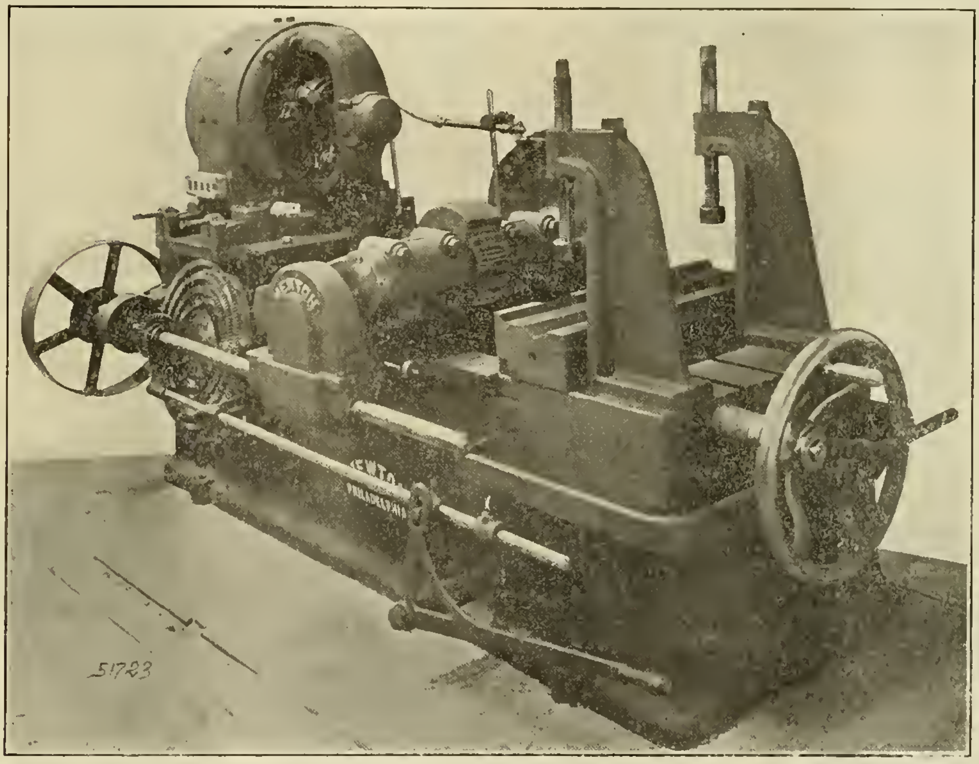
A new, cold saw, cutting off machine designed chiefly for rapid work in cutting heavy stock, is shown in the accompanying illustration. In addition to cutting off bars, slabs, shafting and I beams, this machine is also adapted to a variety of other work. It can be used to advantage in many cases to do some of the work that is usually done on slotters, planers or even milling machines with considerable saving of time. The saw is similar in general design to the one described in this journal November, 1909. It is, however, of more massive construction, greater rigidity and has some marked improvements in many of the details.

The capacity of the machine is 7½ in. round stock; 7 in. square stock; 15 in. I beams in a vertical position, on a square or miter cut, and 5 in. wide by 15 in. high for material with oblong section. Reference to the illustration will show the convenient arrangement of the operating levers and the simplicity in design and massive construction throughout, especially in the spindle, and its wide, capped bearings. An exceptionally broad faced, forged steel, spur driving gear is mounted in the middle of the shaft between the two main bearings. All the bearings where necessary are fitted with bronze bushings. Power is transmitted through the worm driving shaft and a steel spur gear cut from the solid shaft on which the worm wheel is mounted. The construction of the worm wheel and worm together with the roller thrust bearings, all of which are encased to permit them to run in an oil bath, is practically the same as that on the machine described in the issue referred to above. The same rigid and massive construction is provided in the spindle saddle with wide, square bearing surfaces on the frame of the machine and underlocking gibs, adjustments for wear being made by means of taper shoes.

A positive feed with four changes ranging from ¼ in. to 1½ in. per min. has been substituted for the continuous friction feed which was formerly used on the similar machines. This change is the result of special tests at the works of manufacturers in which it was found that the positive feed is much more efficient and better adapted to rapid work. This feed with its automatic, positive safety release arrangement, governed by a set of stops, tripped by adjustable dogs on the saddle, has been tested for the period of over a year and found very satisfactory.

Modern, inserted tooth saw blades are used, fitted with a hold-back to eliminate chattering when cutting material with thin sections, and structural steel which does not permit the engagement of two or more teeth of the saw at one time. The method of securing the saw blade to the end of the spindle has been greatly improved to be consistent with the general rigidity of the machine. This is accomplished by means of a circular plate fastened with one bolt at the center and secured further by six small flush pins arranged in a circle along its outer edge and extending through the saw blade. This arrangement not only saves time in removing and applying blades, as only one bolt must be removed instead of six, but it adds to the strength of the joint.

In the new lubricating system for the cutter blades the only change consists of including the oil storage tank in the base casting of the machine, thus eliminating the separate tank which has been in use. The system includes a small geared pump and attachments with piping extended to the point of cutting so that the lubricating and heat absorbing materials are delivered where they are the most effective.



NEWTON COLD SAW CUTTING OFF MACHINE.

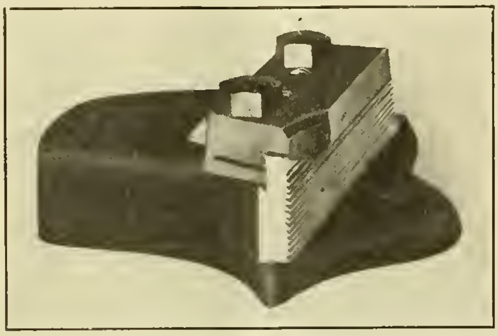
This cutting off machine is manufactured by the Newton Machine Tool Works, Philadelphia, Pa. The worm driving shaft may be connected either to a motor, mounted on the end of the machine with a belt, gear or silent chain, or to a countershaft which is furnished when desired.

LATE TRAINS IN NEW YORK STATE.—During June there were 63,717 passenger trains operated over the steam railways in the State of New York. In the corresponding month, 1909, there were 55,551 trains and in 1908, 50,122. This year 88 per cent. of the trains were on time at division terminals. The average delay for each late train was 21.2 minutes. The causes of delay were as follows: Waiting for connections from other divisions, 28.3 per cent.; work at stations, 18.5 per cent.; waiting for connections with other railways, 11.5 per cent.; trains ahead, 7.6 per cent.; wrecks, 7.2 per cent.; engine failures, 6.9 per cent.; meeting and passing trains, 6.4 per cent.

NEW DIE HEAD FOR PIPE THREADING.

For use on pipe threading machines using a stationary head, the Landis Machine Co., Waynesboro, Pa., has designed a new die head which can be mounted on the carriage of any of the standard pipe machines, and is arranged for manual operation in opening and closing the dies.

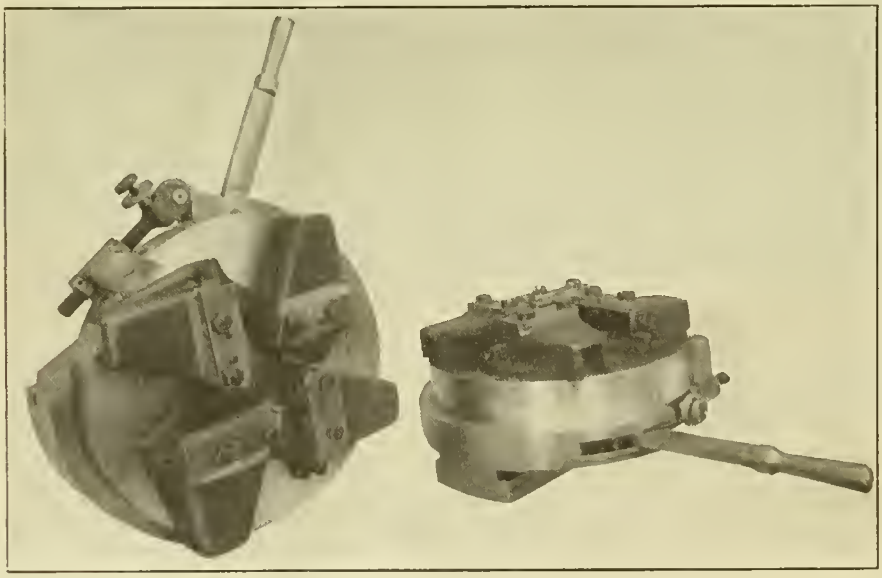
This head incorporates the use of the well-known Landis chasers which are made of high speed steel and only require grinding on the ends for sharpening. Their life is limited only



TYPE OF HOLDER USUALLY FURNISHED ON THE NEW LANDIS DIE HEAD.

by their length. After being ground at the angle giving the proper clearance for the material to be cut, they are quickly reset in the holders, the proper location being obtained by a small gauge furnished with the head.

Two types of holders can be obtained with this head, the ones shown in the illustration, which are not arranged for cutting close to a shoulder, being generally furnished. These holders, as in fact is the whole head, are made of steel. The clamp is so constructed that in addition to holding the chaser rigidly also



NEW LANDIS STATIONARY DIE HEAD.

protects it in case the pipe splits. It comes down over the throat of the die and is rounded out near the cutting point so as to act as a guide for rough ends, and at the same time when a twister occurs in the pipe the strain is thrown, in great part, on the clamp, thus protecting the die in such manner that the liability to breakage is small. When it is desired to thread close to a shoulder a clamp is used which comes flush with the front edge of the chaser only, thus permitting the die to run close up as in threading short nipples, etc.

This type of die admits of cutting speeds decidedly higher than the hobbed type, and since the clearance can at all times be ground to suit the quality of the material in the pipe, ideal cutting conditions are obtained.

The heads are graduated for setting the dies to the different diameters to be threaded. It is opened and closed by hand and when in the closed position the die is rigidly locked, but opens and closes freely by means of the lever. All dies are made to interchange perfectly, and if one chaser of a set should be worn out in advance of the others, this single chaser can be replaced without replacing the entire set.

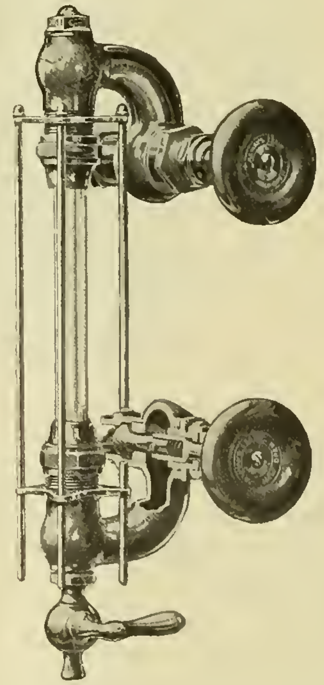
Dies of any one pitch will interchange on any of the die heads so long as the pitch is within the range of the head. For example, dies for threading 1 in. pipe on the 1 in. head will also thread 1 in. pipe on the 2 in. head, or vice versa, thus avoiding the necessity of carrying a large assortment of dies to cover the range of work when using a number of these heads. Of course, one set of dies will also cut all sizes having the same number of threads, as from 1 in. to 2 ins. for example.

AN AUTOMATIC SAFETY WATER GAUGE.

The Swartwout Automatic Safety Water Gauge, manufactured by the Ohio Blower Co., eliminates, to a large degree, the dangers resulting from broken gauge glasses. Quick-closing automatic valves are arranged to cut off the flow of water and steam the instant the glass breaks.

In each of the two gauge bodies there is an automatic valve held away from its seat while in use by a spring, shown at F in the sectional view. In case of breakage this valve is closed quickly by the steam pressure in the boiler. The valve is also controlled by the hand wheel, so that both valve and valve seat are easily removed for cleaning without disturbing the gauge at the boiler connections and without removing the packing of the gauge glass.

As shown in the sectional view, the screw E holds the parts



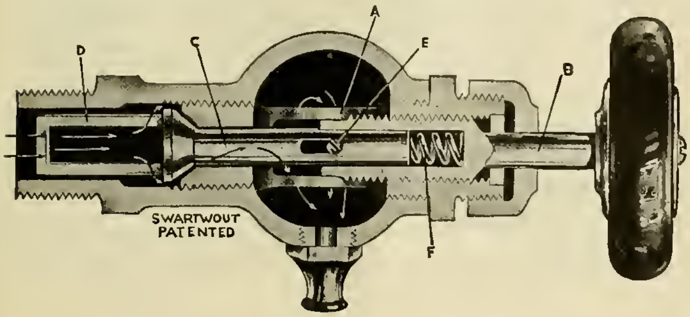
AUTOMATIC SAFETY WATER GLASS.

of the valve together, and when taken out with a small screw driver or penknife all the parts are released. At the inner end of the valve stem C a flat scraper D loosens any sediment adhering to the boiler connection and as it revolves with every turn of the hand wheel the opening is cleared frequently. The removable valve case A is provided with two external threads of the same pitch, but of different diameters, so that the threads on the inner end may slip by the outer internal thread when inserted. The threads are cut so that both sets engage the threads of the gauge body at the same time, thereby insuring a good fit.

On replacing a broken glass the hand wheel is turned forward until the valve is forced from its seat, thus allowing water or steam to flow from the boiler into the gauge glass; the valve on the other gauge body will then automatically open to equalize the pressure. In turning the hand wheel forward to force the valve from its seat, the movement of the spring F in stem B must first be taken up before the valve moves. Every turn of the wheel turns the valves upon their seats. In this way they regrind themselves automatically.

When the valve case is removed there is an unobstructed opening into the boiler 1 inch in diameter, obtained without in any way disturbing the gauge bodies.

Another ingenious feature of the Swartwout Gauge Glass is the gooseneck gauge body. This form of construction allows a

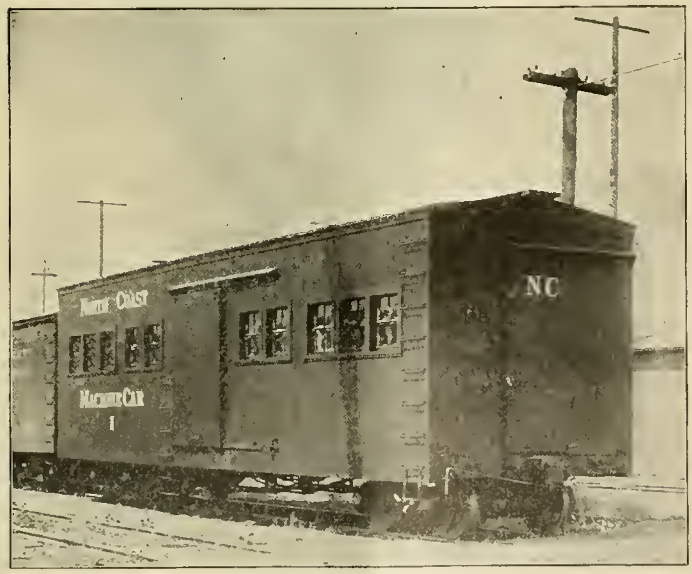


DETAIL OF SWARTWOUT SAFETY WATER GAUGE.

gauge glass 2 to 4 inches longer than usual, thus giving greater visible range of water level. Offsetting the gauge glass renders the operation of replacing a broken gauge glass an easy task. It is inserted through either the top or bottom of the gauge without in any way disturbing the valves or seats. It need not be of any particular length, an inch or more making no difference. It permits the use of softer packings, which with the flexible construction relieves the strain on the gauge glass, thereby greatly reducing breakages. In cleaning also the value of the gooseneck is apparent, for by simply removing the top plug or the drain cock at the bottom, the swab for cleaning is easily inserted, without in any way disturbing the valves or gauge bodies.

SELF PROPELLED MACHINE SHOP.

The North Coast Railroad is a new line being built through central and western Washington from Spokane to the Cascades. During the construction there are, of course, a large number



MACHINE SHOP ON WHEELS.

of locomotives and cars in regular service which are continually getting further and further away from the base and in order to properly maintain this equipment a traveling machine shop has been designed.

This shop consists of a specially constructed, very large box car with numerous windows on each side, which encloses the gas engine for driving the tools and a selection of tools suited for the work to be done. The gas engine is a 12 h.p. Fairbanks-Morse and is connected through a friction clutch to the wheels, so that the car is capable of going from place to place under its own power and can also do switching to get into the most convenient location. It is capable of a speed of about 10 miles per hour. In the car are conveniently located the following tools driven by belts from line shafting running along each side of the roof: 23-inch engine lathe; 16-inch shaper; 1½-inch bolt cutter; 22-inch vertical drill; 6-in. pipe threading machine and emery wheel. The car is 39 ft. 10 in. long, 9 ft. 6 in. wide and 9 ft. high inside.

STEAM AND AIR FLOW METERS.

It is often desirable to know and obtain a constant record of the amount of steam or air flowing through pipes which furnish a supply to either separate pieces of machinery or to a whole plant. The Pitot tube has been used for this purpose with a fair degree of accuracy when making an efficiency test of a plant or some piece of apparatus, but in those cases it is necessary to make frequent observations and records, and up to recently there

INTERIOR OF MACHINE SHOP CAR.

has been no instrument which could do this automatically and present the results as a graphical record.

Realizing the demand for an instrument of this kind, the General Electric Co. has recently perfected a meter which furnishes a record on a roll of paper similar to the record from a Boyer speed indicator. These instruments have been very carefully tested and checked and have been found to be very accurate. They can be installed on any pipe line with little difficulty and no rearrangement of the connections and are arranged so as to register accurately for either a constant flow or an intermittent flow, as desired.

A modification of the Pitot tube principle is used in this instrument, which in brief consists of placing a U tube carrying mercury, on a balance, so arranged that a change in the level in the two legs of the tube tends to destroy the balance of the beam, which tendency is recorded by a pen point on a roll of paper through the medium of a series of counterbalanced levers.

A brass nozzle and plug, shown in Fig. 1, is inserted in the piping at the place where the flow is to be measured. This nozzle carries two sets of openings, one facing the direction of the flow and extending diametrically across the nozzle and the other a trailing set consisting of two openings, one at 90 degs. and the other at 180 degs. in the direction of the flow. The impingement of the steam against the leading openings sets up in them a pressure equal to the static pressure plus that due to the velocity head, while the trailing set is affected by the static pressure less that due to the velocity. The difference in these values is a measure of the velocity and for constant temperature and pressure gives the rate of flow. The pressures in the two sets of openings are connected through separate longitudinal tubes to the plug, and from there by ¼-in. pipes to the meter.

Figure 2 shows the whole apparatus as connected with pipe

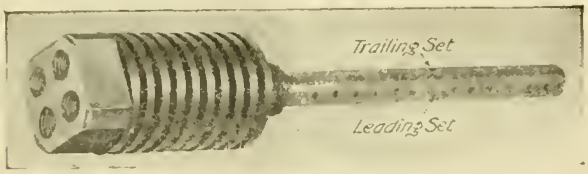


FIG. 1.

and Fig. 3 the details of the recording meter. In this are two cylindrical hollow cups filled to about one-half their height with mercury and joined at the bottom by a hollow tube. This U tube is supported on and free to move as a balance about a set of knife edges. The two pressures from the plug are connected to the cups by flexible steel tubing, which offers a minimum resistance to the movement of the balance. The greater pressure acting upon the left hand cup, for instance, forces more mercury into the right hand cup and thus tilts the beam about the knife edges until the movement of the counterweights at the extreme right of the meter exactly balances the displacement of the mercury. This movement is multiplied by levers and registered by the pen upon the roll of paper, which is driven by an eight-day clock at a rate of about 1 inch per hour, this roll being properly ruled to show the flow in lbs. per hour.

Proper correction weights and adjustments are provided to adapt the instrument to any degree of pressure or temperature. In cases where the pressure varies more than 10 lbs. from the

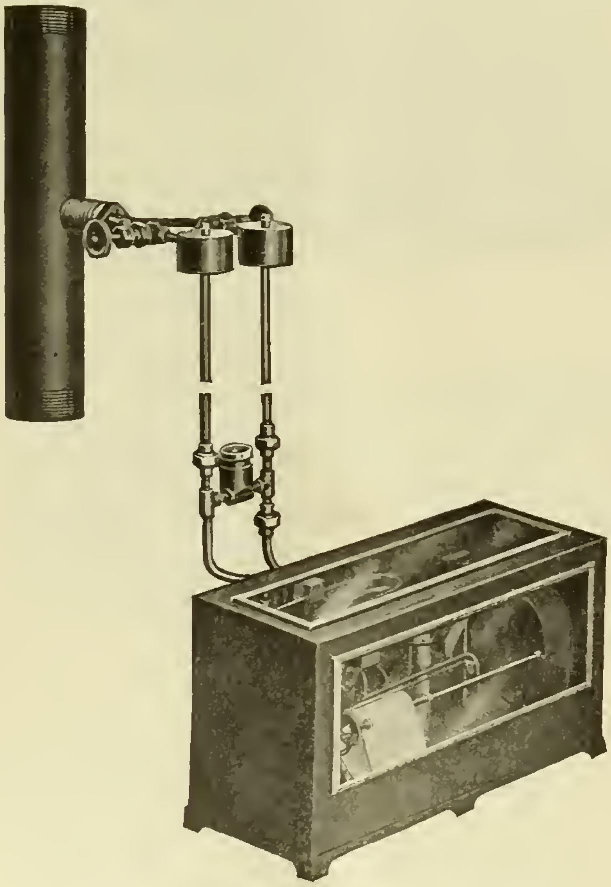


FIG. 2.

normal, an automatic correction device is included to compensate for the error thus introduced on the instrument set for a constant pressure. This consists of a hollow spring similar to the pressure spring in the steam gauge and is connected so as to be influenced by the static pressure of the steam at a point

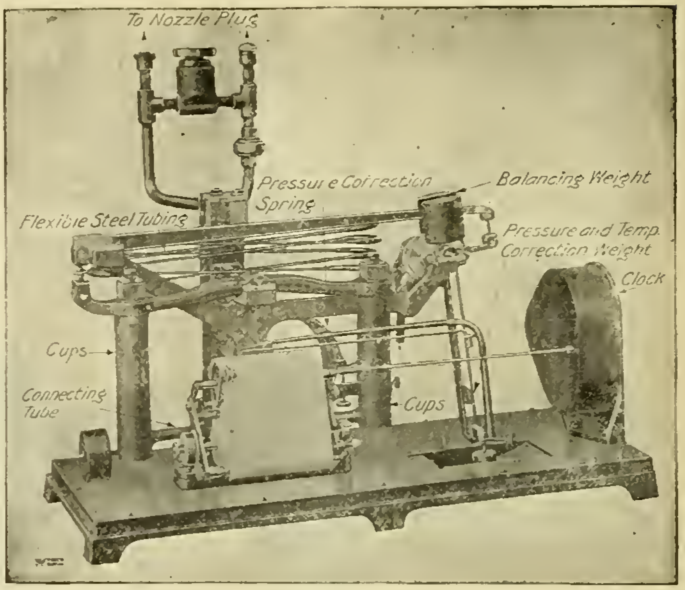


FIG. 3.

where the flow is being measured. The movement of this spring actuates a small correction counterweight and permits an accurate record being obtained for any rate of flow under varying pressure.

An instrument which will indicate, but not graphically record, the rate of flow of steam or air is shown in Fig. 4. This instrument is arranged on the principle of a float on the surface of the mercury in a U shape tube, which actuates a pulley that in turn moves a small U magnet. This magnet affects an indicating needle mounted in a separate cylindrical casing and registers on a calibrated dial, as shown in the illustration.

These instruments, since their introduction a short time ago,

FIG. 4.

have proven to be of great value not only for test work, but for keeping a close watch on the daily operation of various machines and the immediate determination of any unusual condition that might lower the efficiency. The General Electric Co., Schenectady, N. Y., is issuing a very fully illustrated catalogue that gives the sizes suited to different conditions.

Traffic Through the Soo Canals.—There were a total of 3,242 vessels passing through the U. S. and Canadian canals at Sault Ste. Marie in July, 1910. These vessels carried a total of nearly ten million tons of freight. Of this seven and a half million was east bound and two and a half million west bound.

MEN WANTED.

PUBLICITY MANAGER.—Man capable of handling the preparation of catalogs and bulletins and special literature for a railway supply company. Address A. H. A.

CAR DRAFTSMAN.—Experienced man on car design, especially passenger cars, on prominent eastern railroad; excellent opening for the right man. Address W. R. M.

LOCOMOTIVE DRAFTSMAN.—Two or three men experienced in locomotive design and construction wanted by large road in the southwest; salary $80 to $100. Address H. H. M.

POSITIONS WANTED.

MECHANICAL ENGINEER OR CHIEF DRAFTSMAN.—Long experience in the drafting room of railways; at present chief draftsman; wishes position on a southern railway. Address P. F. R.

CHIEF DRAFTSMAN OR SIMILAR POSITION.—Technical man, seven years' railroad experience; now leading draftsman on locomotive and electrical work on one of the largest railway systems. Address E. J. W.

EXPERT ON MACHINE TOOL DESIGN.—Has had long experience with the design and building of machine tools and dealing with the problems of shop production. Well equipped for duties as director of a trade school or similar work. Address S. C. J.

DESIGNER OF RAILROAD SPECIALTIES.—Man thoroughly experienced in railroad design now chief draftsman of one of the largest systems wishes position with a supply company handling railway specialties, that require a designer of exceptional ability. Address R. L. W.

GENERAL INSPECTOR.—Middle-aged man with technical education; 20 years' experience; expert on fuel, tests, spark throwing and front end arrangements; has held all positions from fireman to master mechanic and from machinist to mechanical engineer. Address S. S.

MECHANICAL ENGINEER OR SALES ENGINEER.—University graduate; twelve years' practical experience as designing engineer and estimator with locomotive car manufacturers; has been chief draftsman on a large western railroad and is a specialist on steel coach calculations, designs, estimates and details. Address H. D. W.

SALES ENGINEER, INSPECTOR OR MECHANICAL ENGINEER.—Graduate in mechanical engineering, with nine years' practical experience in capacity of special apprentice, draftsman, chief draftsman, roundhouse foreman, mechanical inspector and chief estimator with railroads and steel car manufacturing concern. Thoroughly experienced in mechanical lines and exercising of executive ability. Address S. F. W.

PERSONALS.

W. R. WOOD has been appointed engineer of tests on the Great Northern Ry., with office at St. Paul, Minn.

CHARLES F. ROBERTS has been appointed assistant locomotive superintendent of the United Railways of Havana, with office at Havana, Cuba.

H. L. JACE has been appointed master mechanic of the South Dakota Central Ry., with offices at Sioux Falls, S. D., succeeding C. A. Swan, resigned.

WM. HILL has been appointed master mechanic of the Iowa Central Ry. at Marshalltown, Ia., succeeding C. E. Gossett.

M. FLANNAGAN has been appointed master mechanic of the Richmond division of the Chesapeake & Ohio Ry., with headquarters at Richmond, Va.

D. P. KELLOGG, master mechanic of the Southern Pacific Co. at Los Angeles, Cal., has been appointed shop superintendent of the Los Angeles general shops.

W. V. O'NEILL has been appointed master mechanic of the Crystal City and Uvalde Railroad, with office at Crystal City, Texas, succeeding J. S. Hardwick.

C. J. ANDERSON, formerly master mechanic of the National Lines of Mexico, has been appointed assistant superintendent of the Southern Pacific Co. at Nazatlan, Mexico.

F. A. BUTLER has been made master mechanic of Boston division of the Boston and Albany R. R., with office at Beacon Park, Allston, Mass., succeeding J. B. Canfield, transferred.

E. J. SEARLES has been appointed assistant to the general superintendent of motive power of the Baltimore & Ohio R. R. Co. and Baltimore & Ohio Southwestern R. R., at Baltimore, Md.

T. H. HAGGERTY has been appointed smoke inspector on the Chicago terminal division of the Chicago, Rock Island & Pacific Ry., with office at Chicago, succeeding E. A. Lutzow, resigned.

THOMAS O'LEARY, master mechanic on the Tucson division of the Southern Pacific Co., at Tucson, Ariz., has been appointed master mechanic at Los Angeles, Cal., succeeding D. P. Kellogg.

L. L. WOOD has been appointed acting superintendent of motive power and machinery of the Evansville & Terre Haute R. R., with office at Evansville, Ind., succeeding G. H. Bussing, resigned.

W. C. PETERSON, round house foreman of the Southern Pacific Co. at Yuma, Ariz., has been appointed master mechanic on the Tucson division at Tucson, Ariz., succeeding Tom O'Leary, transferred.

C. H. HOGAN, division superintendent of motive power of the New York Central & Hudson River R. R. at Depew, N. Y., has been appointed assistant superintendent of motive power, with office at Albany, N. Y.

J. B. CANFIELD, master mechanic of the Boston division of the Boston & Albany R. R., has been appointed master mechanic of the Albany division, with office at West Springfield, Mass., succeeding A. J. Fries, promoted.

W. B. LILLIS, general foreman, Illinois Central R. R. shops, Waterloo, Iowa, and formerly holding similar positions at Burnside and Freeport, Ill., has resigned, to become superintendent of Greenlee Brothers Company, Rockford, Ill.

GEORGE H. BUSSING, superintendent of motive power of the Evansville & Terre Haute R. R., at Evansville, Ind., has been appointed superintendent of motive power of the Buffalo & Susquehanna R. R. and the Buffalo & Susquehanna Ry., with office at Galeton, Pa.

A. J. FRIES, division master mechanic of the Boston & Albany R. R., at Springfield, Mass., has been appointed division superintendent of motive power of the Western division of the New York Central & Hudson River R. R., with office at Depew, N. Y., succeeding C. H. Hogan, promoted.

C. E. Gossett, master mechanic of the Iowa Central Ry., at Marshalltown, Iowa, has been appointed master mechanic of the Minneapolis & St. Louis Ry., with office at Minneapolis, Minn., succeeding J. Hill, resigned.

CATALOGS.

Chambers Throttle Valve.—The Watson, Stillman Co., 50 Church St., New York, is issuing Catalogue No. 80, which very fully illustrates and describes the Chambers throttle valve, that is made the subject of a descriptive article in another part of this issue.

Adapter Bearings.—A leaflet being issued by the Hess-Bright Mfg. Co., Philadelphia, Pa., shows how ball bearings can be adapted to any point on a shaft, where a hanger can be located, without difficulty. A bushing is applied to the sbaft and secured by taper pins and on this the ball races are mounted in a very simple manner.

Fire Extinguisher.—"Success" fire extinguishers in hand operated sizes as well as larger ones mounted on a truck are the subject of a leaflet being issued by the H. W. Johns-Manville Co., 100 William St., New York. These extinguishers are most substantially constructed and are intended to be thoroughly durable as well as thoroughly efficient.

Throttle Stem Packing.—A leaflet being sent out by the Plunger Plastic Packing Co., St. Paul, Minn., illustrates an entirely new design of stuffing box for throttle stems, which it is claimed is absolutely leak proof and can be applied with a full head of steam in the boiler. This packing is applicable to old as well as new construction and uses but one size packing for all size throttle rods.

Acetylene Lighting.—The safety, convenience and reliability of the acetone system of storage for acetylene gas is now very fully accepted and recognized by all railroad men, as well as automobile owners. The Commercial Acetylene Co., 80 Broadway, New York, which controls this type of apparatus for all railroad uses, are issuing two attractive catalogues or pamphlets, one being devoted to standard locomotive headlight equipment and the other to railway car lighting equipment. These catlogues briefly cover the essential features of both of these equipments and will be found to be of decided interest to motive power officers.

Coal and Ore Handling Machinery.—A most attractive publication, consisting of an exceptionally well chosen series of photographs in sepia on a rough coated paper, is being issued by the Brown Hoisting Machinery Co., Cleveland, O. These photographs, to the number of 62, illustrate the most modern arrangement of machinery for handling any product that is capable of being conveyed with a clam shell bucket. They include some of the very largest coal and ore handling plants in the world and in many respects this exhibition, in the shape of photographs, is far more impressive than any statement of sizes and capacity could possibly be.

Car Heating.—Complete half-tone illustrations, sectional and perspective line drawings and table showing names of different parts, together with descriptive matter of the different systems, make up a large part of the 165 page catalogue, each sheet measuring 9 x 12, being issued by the Gold Car Heating and Lighting Company, Whitehall Building, New York. The Gold systems include those for steam, vapor, hot water and electric heating, acetylene lighting and systems for ventilation of railway cars. It would be impossible in a brief space to begin to indicate the scope of this book, and it is only possible to say that it is complete and contains a very complete index for quick reference.

Electric Headlight System.—The complete apparatus for generating and using electric current for head and cab lights on steam locomotives is the subject of Bulletin No. 101 from the R. G. Peters Mfg. Co., Grand Rapids, Mich. This system includes an efficient steam turbine direct connected to an electric generator mounted in a compact manner. The generating apparatus is most fully described and illustrated in the catalogue, each particular detail being considered separately. The same is true of the arc lamp for the head light, which can be furnished with either copper and carbon terminals, or with two carbon terminals, either vertically or horizontally arranged. Also included are the results of tests made at the University of Illinois, which shows the steam consumption, candlepower, etc., of the apparatus.

Brake Beams.—Ninety pages, 6 by 9 in. size, each containing a full dimensioned and detailed line drawing of a brake beam or bolster, is being issued by the Chicago Railway Equipment Co., McCormick Building, Chicago, Ill. In addition there are included some reproductions from photographs of the various beams and also illustrations of roller side bearings, adjustable brake heads, slack adjusters and journal boxes. This method of showing its product by dimensioned drawings most carefully made and large sized reproduction of photographs unaccompanied by any comment or descriptive matter, will be appreciated by railroad men who often have need of exactly the information here given and find it unavailable in most catalogues. The book is of the loose leaf variety and will be extended as new designs are brougbt out.

Cutter Heads for Wood Work.—Catalogue No. 30, from Samuel J. Shimer & Sons, Milton, Pa., contains 224 pages given up to illustrations accompanied by brief descriptions, details of sizes, and prices of the exceptionally large variety of cutter heads manufactured by them. Many pages in the catalogue carry illustrations of cross sections of lumber of various kinds, which are dimensioned and show exactly the character of work the various heads are arranged to do. Some of these mouldings and ceilings are unusually complicated in appearance, but the cutter heads are as simple for them as for ordinary tongue and grooving. This company also furnishes cylinders to order to fit any surfacing or planing machine; in fact, this catalogue clearly indicates that there is nothing in the shape of a cutter for wood work that cannot be obtained from this company.

Portable Acetylene Lights.—The value of a strong, efficient and simply operated portable light is thoroughly appreciated by railroad men in all departments. If the apparatus is properly designed, acetylene offers probably the most satisfactory source for a light of this character and the arrangements shown in the catalogue being sent out by the Alexander Milburn Company, 507 West Lombard St., Baltimore, Md., fully covers the field. These lights are furnished in any size, to be carrried as a hand lantern as well as stationary lamps, which are easily transported by one man, and also in larger sizes where the lamp, through the medium of a hose, can be placed in any satisfactory location, the generator being some distance away. These lamps are made in all sizes up to 5,000 candlepower. The catalogue includes complete tables of sizes and gives the price of each arrangement.

Coupler, Draft Gears and Steel Castings.—A loose leaf catalogue with most susbtantial covers, printed on exceptionally highly finished paper, which brings out the details of the illustrations to the very best advantage, is being issued by the Gould Coupler Company, 341 Fifth Ave., New York. This catalogue contains 146 pages and is arranged to show in large size, retouched, half-tone illustrations, line drawings and concise descriptive matter the large assortment of car and locomotive parts manufactured in the various malleable iron and steel casting plants of this company. The first part of the book is given up to freight couplers of the Gould pattern, which has more than kept pace with the modern requirements. Following this are friction draft gears, in which section are included drawings showing the application of this gear to different types of cars. Next follow cast steel body and truck bolsters and cast steel end sills, followed by cast steceel truck frames. Hartman ball bearing centre and side bearings are then considered, this section including comparative tests carried out in some detail and deductions as to the saving in coal and water possible by the use of bearings of this kind. Phantom views of journal boxes clearly illustrate the internal arrangement and advantages of the Gould insert journal box lid. The next section of the catalogue covers the same parts and appliances as furnished for passenger cars and here are also given friction and spring buffers, standard vestibules, etc. The section on locomotive equipment includes couplers for tenders and pilots, buffers and journal boxes for tenders. The next section is on electric traction appliances and sbows the Gould radial buffer and swing coupler. Steel locomotive and car axles are illustrated and briefly commented upon. Several pages at the end of the catalogue are given up to the apparatus of the Gould Storage Battery Co. for car lighting. This catalogue is furnished with the idea of furnishing a busy man with exactly the information he requires with the least expenditure of time. It is substantial and suited for hard usage, while at the same time being most attractive in every particular.

NOTES.

Grip Nut Co.—E. R. Hibbard, president, accompanied by his wife and son, left Chicago July 28 for a ten weeks' trip to the Orient.

T. H. Symington Co.—E. H. Symington has been appointed mechanical expert of the above company and will be located in the Chicago office of the company, 316 Railway Exchange.

Railway Steel Spring Co.—It is with profound regret that we have to chronicle the death of William H. Silverthorn, president of the above company. Mr. Silverthorn was 61 years of age, and died at his home in Painesville, Ohio, on August 13.

C. W. Hunt Co.—Arrangements have been made by the above company, of New York, builders of coal handling, conveying and hoisting machinery, by which their business on the Pacific Coast will be handled by the San Francisco Bridge Company, with offices at 865 Monadnock Building, San Francisco, Cal. This company has just completed a coaling station in San Francisco for the government.

Locomotive Superheater Co.—It is announced that the above company has acquired the United States and Canadian rights under the basic patents upon fire tube superheaters. There are in successful operation or in course of construction in Europe over 6,000 of these superheaters and in America more than 800 have already been installed. These patents include the inventions of Messrs. Wilhelm Schmidt, H. H. Vaughan, A. W. Horsey, Francis J. Cole and others. The principal office of the company is located in the Hudson Terminal Building, 30 Church Street, New York.

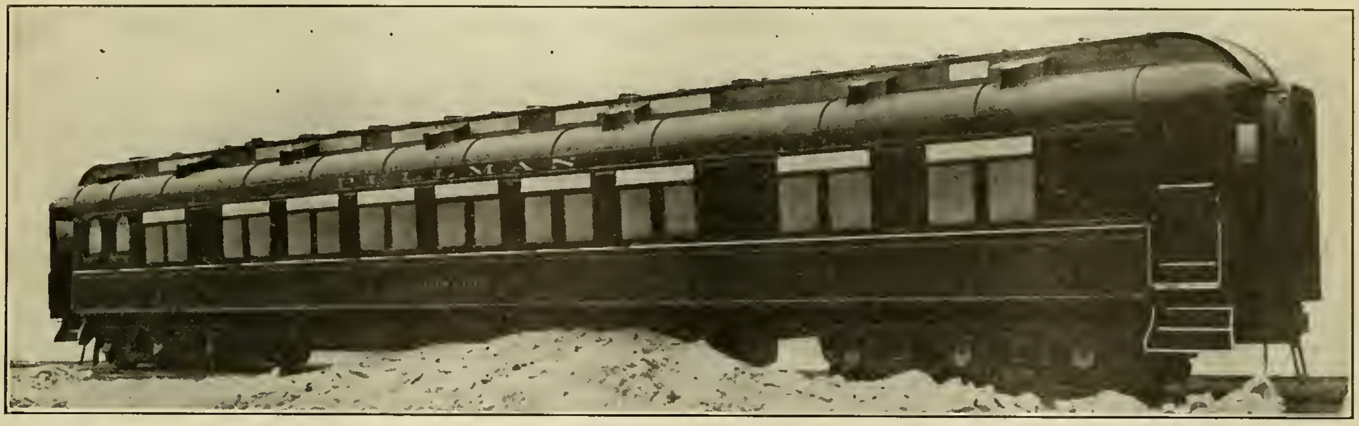
All Steel Pullman Cars

THE PULLMAN COMPANY HAS PERFECTED A DESIGN FOR ALL STEEL SLEEPING, PARLOR, CLUB AND PRIVATE CARS, WHICH PERMITS THE USE OF A STANDARD UNDERFRAME COMPLETE AND MANY OTHER STANDARD PARTS FOR ALL CLASSES OF CARS. THE FOLLOWING DESCRIPTION APPLIES PRINCIPALLY TO THE SLEEPING CARS.

The Pullman Company now has in service on the Pennsylvania over 300 all-steel cars, representing about half the steel equipment required for operation on this system in connection with the New York terminal project. The cars are being placed in service as fast as they can be built and cover three varieties of sleeping cars, parlor cars, observation cars, club cars and private cars.

These cars are radically different from the first steel sleeper built and named for the Jamestown Exposition,* where it was exhibited. This car is remarkable for the almost imperceptible effects the subsequent continuous service has left upon it. However, its construction was so heavy as to cause doubts in the minds of railway motive power and operating officials as to its practicability. Realizing this, the Pullman Company endeavored to secure a lighter construction without any sacrifice in structural strength and built five club cars very similar to the present standard designs.

The cars now running and under construction as per the designs here reproduced probably exemplify the highest development of the steel car building art. In general characteristics, appearance and over-all dimensions all classes of these cars are identical. The outside elevation is square with pressed prism plate combination gothics and deck lights, continuous sash rest, round-top high windows of pressed prism plate glass, interlocking steel sheathing of 1½ in. face below the letter board, Pullman standard roof, hood and vestibule. The outside is painted Pennsylvania standard colors and striping so as to secure a uniform train appearance.

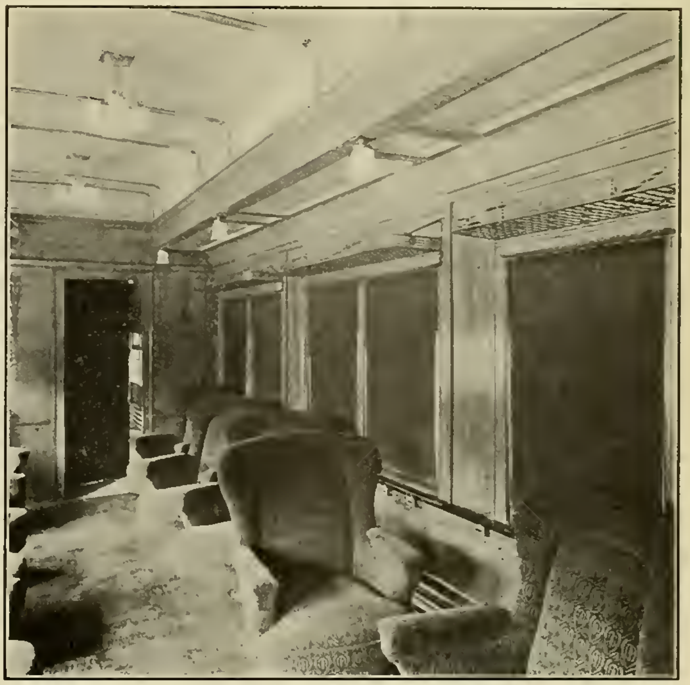


AN ALL STEEL PULLMAN SLEEPING CAR.

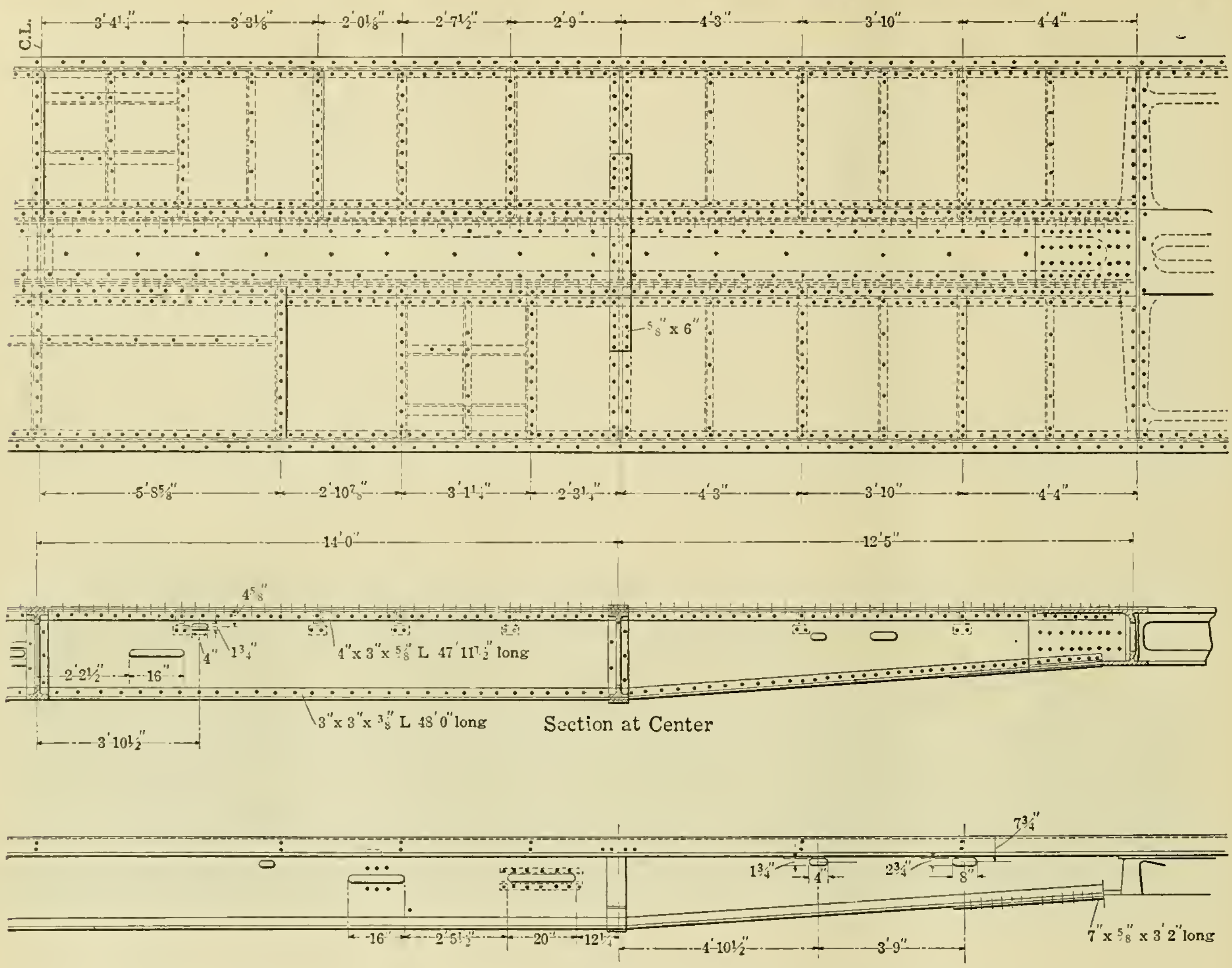
The body of these cars weighs on the average 100,000 pounds and the two trucks 43,500 pounds. This is a very creditable result, the total service weight being but from 12 to 15 per cent.

* See American Engineer, April, 1907, p. 130.

INTERIOR VIEW OF SLEEPING CAR. THE CEILING IS FLAT.



INTERIOR VIEW OF PARLOR CAR. A BEAMED CEILING IS USED.

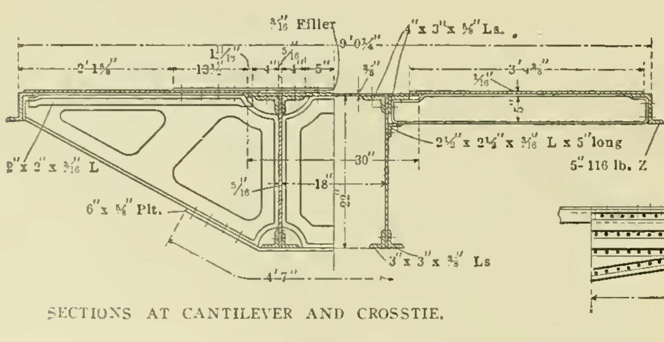


Side Elevation

greater than the standard wooden sleeping cars.

Framing.

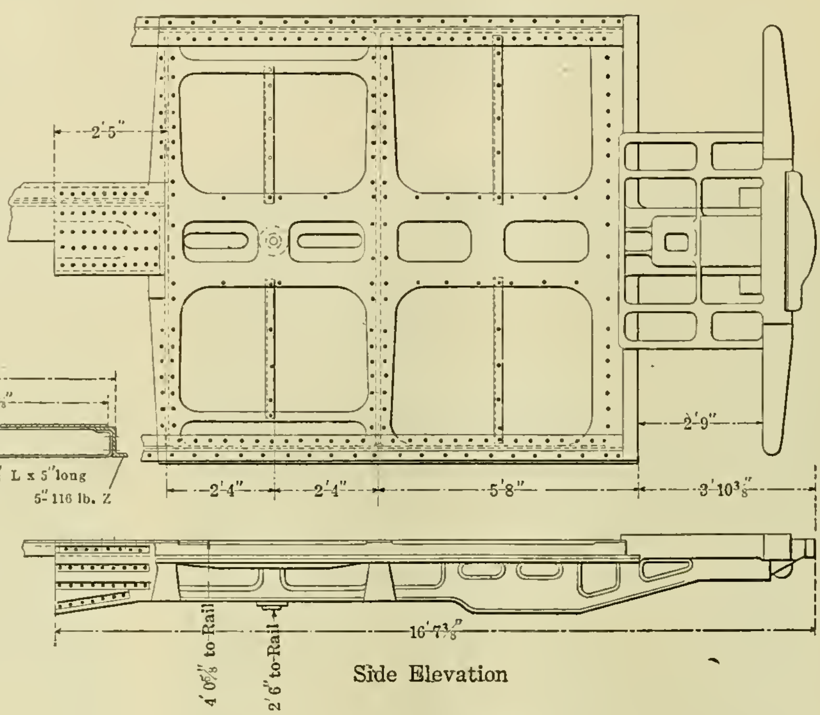
The car is framed to meet M. C. B. recommendations for steel passenger equipment, the same as the Pennsylvania all-steel equipment* with which these cars are to run. The center sills are designed to carry all of the load and resist the service end-shocks. The weight of superstructure and loading is transferred to the center girder at the ends, by the large combined platform and bolster casting and at two inter-



SECTIONS AT CANTILEVER AND CROSSTIE.

mediate points on each side, by cast steel cantilevers.

The center sills, spaced 18 in. apart, are fish-bellied, built up of a 30 x ⅜ in. top cover plate; 2 upper flange angles 4 x 3 x ⅞ in.; 2 web-plates 5/16 in. x 1 ft. 10 in. deep, continuous between end castings; and 2 bottom flange angles 3 x 3 x ⅜ in.. The whole section provides an area of 50 square inches at the center of the car. The use of heavier angles at the top of the web than at the bottom, together with the heavy cover plate, raises the neutral axis so that it is almost concentric with the line of action of the resultant end



THIS UNDERFRAME IS SUITED FOR FOURTEEN DIFFERENT TYPES OF CARS.

* See AMERICAN ENGINEER, June, 1907, p. 232; July, 1907, p. 260.

VIEW OF FRAMING FOR SLEEPING CAR.

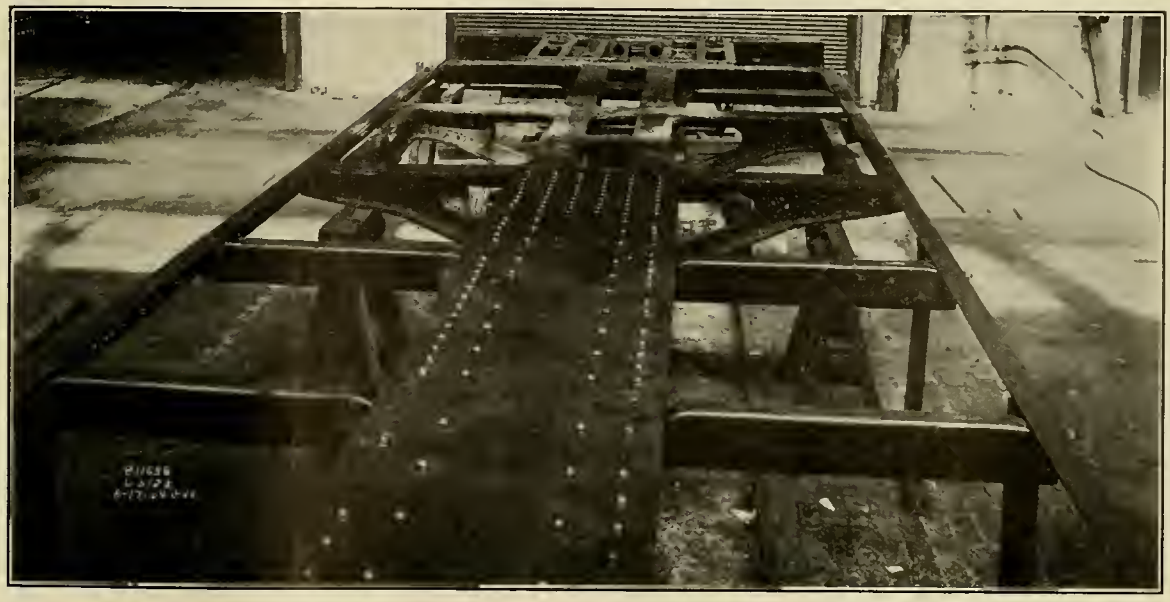
shock. The bending stresses due to eccentric end shock are thus almost eliminated and to the lading stresses but slightly more than the direct compressive end shock stresses need be added to obtain the total stress.

The careful disposition of the metal in the underframe members, thus permits the building of the whole underframe, with a complete covering of floor-plates, under 30,000 lbs. in weight.

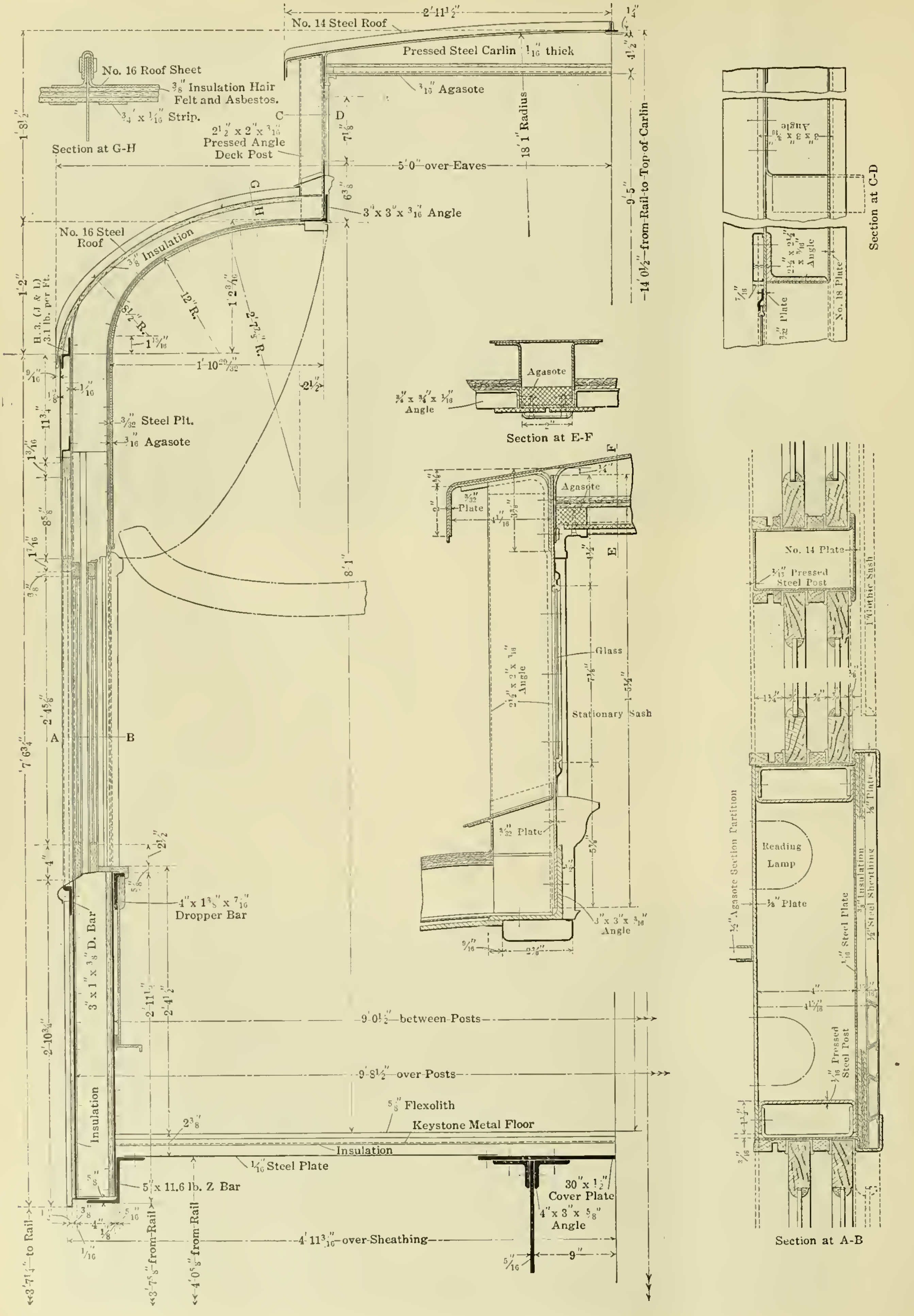
This design of underframe, shown in the illustration, will fit under 14 different types of cars without any modification whatever—a feat of interchangeability. The alignment of center and side-sills is permanently assured by the frequent use of pressed steel transverse cross-ties. The same cross-ties, together with floor stiffener angles placed between them, serve as web stiffeners and splices for the floor girder plates which extend from side-sill to center-sill and from end to end of car. This construction produces an admirable floor-girder well suited for resisting the tendency of buckling sidewise, as a whole.

The large platform and bolster-casting is used for the whole structure and detail of the underframe from the buffer-beam to about 12 feet behind the body end-sill. This casting serves for buffer-beam, platform-sills, safety-chain and pipe-anchors, buffing-housing, trap-door and step-supports, body-end-sill, draft-housing, center-sills, double-body-bolsters, side-bearing-braces, center-plate-bearing, and center-sill-splice. It avoids a multiplicity of parts and riveting and withal weighs but 5,150 pounds. It was designed and built by the Commonwealth Steel Co. The center-sill-splice or the connection of the structural sills to the casting, comes approximately at the point of inflexion of the total bending moment on the center-sills, making it eminently safe.

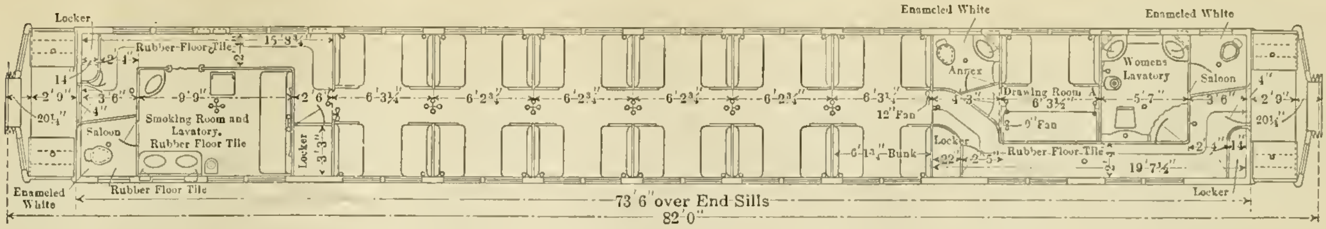
The transverse cantilevers are of cast steel with a center-sill separator between the web-plates, the whole being securely tied



VIEW OF UNDERFRAME. THE COMMONWEALTH STEEL COMPANY'S COMBINATION CASTING IS USED.



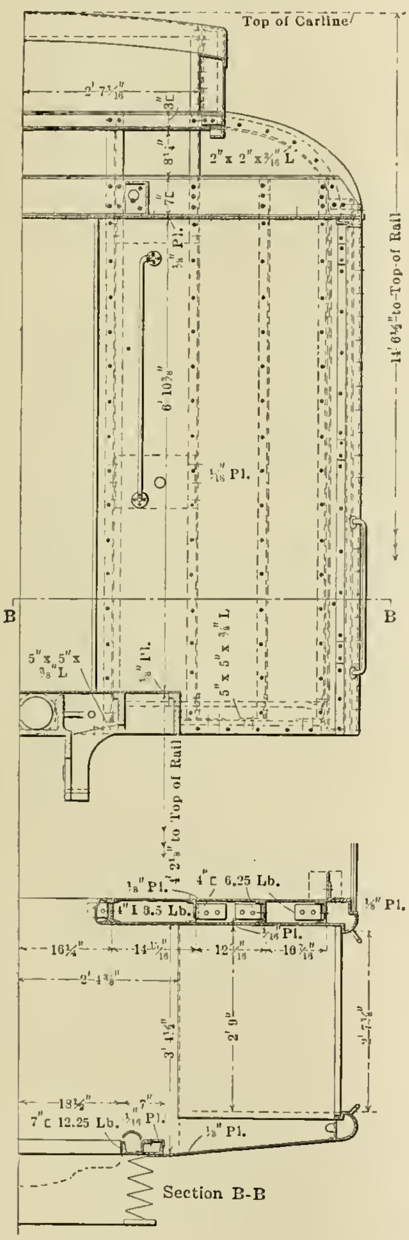
VARIOUS SECTIONS AND DETAILS OF SIDE FRAMING FOR STEEL PULLMAN CARS.



PLAN OF TWELVE-SECTION ALL STEEL SLEEPING CAR—THE PULLMAN COMPANY.

together top and bottom by a 6 x ⅝ in. cover plate, besides being riveted directly through.

The underframe is used for the floor framing direct; above the 1/16 in. floor girder plate is placed a 1 in. layer of magnesia insulation, separated by longitudinal furring strips, to rigidly support the ½ in. keystone flooring. Over the keystone metallic

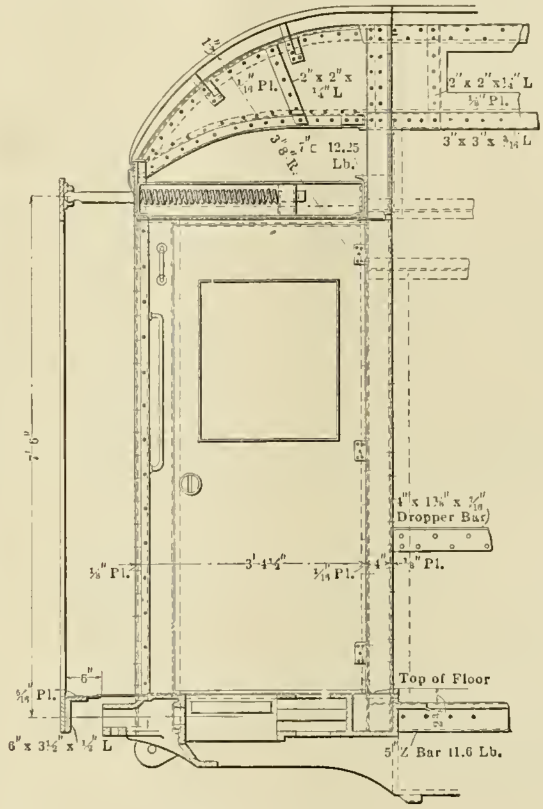


flooring is spread a ⅝ in. layer of flexolith. This floor weighs about 45 pounds per square foot.

On the platform, the floor is simply a ⅛ in. plate covering the casting with ¼ in. rubber tiling on top. The floor of the car is not subject to any noticeable vibration and is a good non-conductor of sound.

The Side Girder.

Due to the use of interlocking steel sheathing, the side girder is placed inside of the car. The lower chord or side sill is a continuous 5 in., 11.6 lb. Z-bar, which section provides the readiest methods of fastening the floor to the side girder, of closing the bottom of the side wall and attaching the sheathing. The upper chord is a 4 x 7/16 x 1⅜ in. continuous dropper bar (Jones and Laughlin) and the web is formed of ⅛ in. steel plates 2 ft. 11¼ in. deep in three lengths per side. The side girder, theoretically, is a continuous beam of three spans, the ends being in a condition somewhere between fixed and freely supported, due to the constraining influence of the steel end casing. The stesses in the side girder do not equal one-third of the permissible amount, the extra metal being required to prevent unsightly deflection in the long central span. This provides for a large degree of elastic deflection, due to overload or service damage, before the car could take a permanent set.



DETAILS OF VESTIBULE.

The side girder is stiffened to provide against lateral bending by the strength of the side posts and the two dropper bars, a 3 x ⅜ x 1 in. dropper bar being used outside, where it also serves as the upper attachment for the sheathing and the face connection of the drawn steel sash rest.

Between these two dropper bars and securely riveted to them, pass the pressed steel side posts. The main post is channel shaped, of ⅛ in. steel and continuous from side-sill to deck-sill, so that they form the lower deck carlines. The window posts are U-shaped of 1/16 in. in. steel and extend from side-sill to lower deck eave. From this point to the deck-sill extends a special ⅛ in. pressed carline, forming the lower deck roof joint and the attachment of roof to body of car.

The Deck Girder.

A continuous 3/32 in. steel plate punched out for ventilators, screens and deck lights forms the deck plate. Securely riveted to it at the bottom is a 3 x 3 x 3/16 in. angle forming the deck-sill and at the top a drawn steel chord forming the eave and water table. The girder is stiffened by upper deck posts of 2 x 3 x 3/16 in. angles.

The Roof.

Three varieties of carlines are used in the upper deck, all made of ⅛ in. pressed steel. The main carline is of U-shaped section and upon it is made the joint of the inside finish. The carline is furred with agasote and drilled for the finish to screw to it. The intermediate carline is of Z-shaped section and is simply one-half of the main carline, which is used to save weight and for the fastening of transoms. The roof joint carline is of ⅛ in. pressed L-shaped steel and is used to attach the roof to the car.

All three types are riveted to the deck-plate through pressed end flanges, the rivets taking both the deck-plate and upper-deck chord.

Running longitudinally from end of car to end of car, in the center of the roof is a 1 x 1 x 1/8 in. T-bar securely riveted to each carline, preserving their alignment and forming the attachment for the longitudinal roof sheet flanges and the joint cover.

In the roof there are no rivets whatever extending from the outside to the inside to work loose and leak; even the connection of the lower-deck roof sheets to the deck-plate is outside. The sheets being split in the center are of a size easy to secure, and the flexible joint allows for temperature changes.

Inside Finish.

Inside finish of steel and agasote, in a very unobtrusive design, with conventional stencil decoration is employed. Fireproof agasote is used for upper-deck ceilings, lining of upper berth, section partitions, and section wainscoting.

Vermilion inside sashes, sash rests, window and curtain stops, and seat back mouldings are used. The bunks are all-steel construction, as are the seats; they are painted a burnt red and mottled in finish, which destroys the effect of the flat color, but does not endeavor to imitate wood graining. The upper-deck in all cars is flat, the lower in the parlor cars is likewise flat with ceiling beams.

Insulation.

The whole car is in reality a double insulated air space, due to the use of "resisto" insulation inside of the cellular sheathing and outside of the steel lining. This insulation is 3/8 in. hair felt sandwiched between sheets of asbestos. Besides the above, the section wainscoting and berth lining still further separate the passenger from the cold outside walls.

Lighting.

Provision for electric light only is made and the cars are wired so that either train line or axle device can be used. The great majority of the cars have not had axle devices applied to them as yet.

Trucks.

The trucks are of the newest cast steel type, using Lappin steel backed brake shoes, Creco beams, McCord boxes and lids, M. C. B. 5 x 9 in. axle, 36 in. Paige wheels, Woods' roller side bearings and Commonwealth Steel Company's castings. The bolster springs are 5-ply 4 x 7/16 in. steel 36 in. long and the equalizer springs of three-coil 9 x 13 in. of 1½, 1 1/16, 11/16 in. rod.

Westinghouse high speed brake is employed using two cylinders and braking trucks independently to 90 per cent. of the light weight of car.

Specialties.

Among the specialties are the following: Garland ventilators, exposed Durer hoppers, Knapp sash locks (inside sash), flush sash lifts and post springs (outside sash), Perfection sash balances, Brown metallic weather stripping, Forsyth ring offset shade fixtures, Pitt drawbars, Westinghouse draft gear, Acme diaphragms, vestibule roller curtains and fixtures, National steel trap doors and Pantosote Company's Agasote for inside finish.

CO-OPERATIVE PLAN OF ENGINEERING INSTRUCTION.

The scheme of instructing students in engineering and similar subjects on the co-operative principle, whereby a certain amount of practical work under regular every-day working conditions is combined with the theoretical instruction in the school, which was originated by Professor Schneider and installed by him in the University of Cincinnati, has attracted widespread attention and is being received with so much favor that other schools and colleges are taking up the idea and devising variations of the original plan to suit the special conditions in each case.

Among the latest of these is the University of Pittsburgh, which has originated a new idea whereby the students get the usual amount of instruction in the college and at the same time get three months each year of practical work in one of the industries around Pittsburgh. In the latest bullettin of the University this plan is described as follows:

"It has been a matter of common observation in connection with the educating of young men who enter the engineering activities that those who spent their vacations while at school in engineering offices and industrial establishments have been better prepared for entrance upon their life's work than their fellow students of otherwise equal abilities who devoted their time exclusively to school work. The contact with the engineering activities, even in this subordinate way, gives the student of engineering an insight into practical affairs which not only makes him of more immediate use to his employer upon graduation from school, but also fits him to pursue his studies to better advantage while in school.

"If the student of engineering is thus benefited by such chance work as he may be able to get during vacation periods, then it is evident that he will be benefited still more by pursuing a systematic course in which the instruction in school is interspersed with suitable outside practical work.

"The technical graduate who has taken school work only has no adequate knowledge of the organization which makes it possible for many men of diverse employment to work together as a single unit in the accomplishment of a desired result, or the system that is necessary for tying together interrelated departments for the attainment of economic production; nor does he even know as a beginner how to apply the knowledge at school in a manner altogether satisfactory to his employer.

"Because of this unpreparedness of the average technical graduate, a number of large corporations have established student apprenticeship courses for the benefit of such graduates as seek employment with them.

"The engineering schools and the companies who employ their graduates are thus working independently in their efforts to prepare young men for entrance upon their life's work. Since both school and future employer have the common aim to fit the young man for efficient service at the minimum of cost in time and money, it is evident that the best results cannot be had by independent action but by co-operation.

"The University of Pittsburgh because of its splendid industrial environment is most favorably situated to apply this co-operative principle to the education of young men who are preparing to enter the engineering industries. Instead of keeping the young man away from the actualities of his life's work for a period of four or more years prior to graduation, as is the general custom of engineering schools, the Committee on the School of Engineering have matured a co-operative plan whereby the student, while spending in school the amount of time usually devoted to instruction in our best engineering institutions, will work four terms of three months each, in the engineering industries of the Pittsburgh District. By this plan the student gets the usual theoretical course and in addition twelve months of practical work, all in the space of four years, the school work being arranged so that successive groups of students will furnish continuous service to the employer."

The schedule of work on this co-operative plan is as follows:

During the first three terms (of from 11 to 12 weeks each) the class is together at the college. In the fourth term of that year it is divided, one-half taking the college work and one-half the practical work. The first term of the following year these halves are alternated and the college work is repeated for the half of the class which was working in the shop during the previous three months. During the next term the sections change places again, as do they also in the third term. In the fourth term of this year the class is united in the college work. During the four terms of the next year the sections alternate regularly and at the end of this year their shop work is completed and the three terms in the following year are devoted entirely to the work in the college. This gives the classes the regular 12 terms in the college work and in addition four terms of practical work in the shops during which time they are earning sufficient to largely reduce the net cost of their education.

Take the School to the Shop.—The fundamental principle underlying this work is the thing I want to try to impress upon you; that is, that the prime feature of apprentice training is in the shop and not in the school. In order to get successful mechanics and successful engineers, you have to take the school to the shop and not attempt to take the shop to the school.—*Prof. Schneider at the General Foremen's Convention.*

British Locomotive Development

A DISCUSSION OF THE RECENT CHANGES IN LOCOMOTIVE DESIGN IN GREAT BRITAIN, THE PROBLEMS WHICH ARE CONFRONTING THE MOTIVE POWER DEPARTMENTS AND THE METHODS BEING EMPLOYED TO SOLVE THEM.

By R. H. Rogers.

A time-honored misconception exists among even prominent railroad men of this country that train service in the British isles cannot be taken seriously in view of the light loads behind the engine; absence of grades and curves, etc., etc., and so deeply have these erroneous ideas become rooted that it is practically impossible to secure serious consideration of a subject which at the present time is certainly not lacking in interest. There is more of a parallel between conditions here and abroad than can possibly be estimated without thorough study on the ground, and the problems which confront them are every bit as difficult of solution as those with which we are so familiar at home.

During a recent trip abroad the writer rode on engines of many British railroads, and he has seen the locomotive on more than one occasion ahead of a train weighing over 400 tons. The ordinary passenger trains of the London and Northwestern; the London, Brighton and South Coast; the Midland, and others average about 280 tons weight behind the engine, and the time of even the unimportant trains is very fast. There are grades as steep as 1 in 40, for a short distance, and rises of 1 in 100 are not unusual on practically any railroad of Great Britain; that is, any railroad can exhibit such gradients. The roads as a whole are far from being level as billiard tables, as many of us have been led to believe, and they are not altogether straight either, although there is, of course, far less curvature than in the United States.

The railroad question of the hour in England is to provide or develop power to continue the justly renowned fast schedules, which for so many years have been in vogue, while the load behind the engine has increased at least 40 per cent. since 1900 When we reflect that the 5.30 P. M. train from London to Crewe on the Northwestern, which consisted in that year of 230 tons, on a schedule of 3 hours and 10 minutes, now weighs 350 tons in 17 minutes faster time, some idea can be gained of the altered circumstances which a few years have brought forth and of the demand which has been imposed on locomotive designers to meet them. Increased power has become an absolute necessity, not so much through increase in speed, but by increase in the weight of rolling stock in proportion to the passengers carried. The slow appreciation on this side of the water of these changed conditions has served to obscure the fact that British locomotive practice is at present in the throes of a metamorphosis which will revolutionize existing equipment, and a mention of what has been done in the transformation of old, and the evolution of new types of engines, is not lacking in interest.

Probably one of the most significant changes in motive power generally in England within the last few years has been the practical retirement of the compound engine. When the twentieth century opened the 3 and 4-cylinder compounds held sway on the London and Northwestern from Carlisle in the north to London in the south, while from Carmarthen in the far west to Peterboro in the east trains were dependent upon these machines for their motive power. All the late Mr. Webb's five classes of 3-cylinder compounds—*Experiments, Dreadnoughts, Teutonics, Greater Britains* and *John Hicks* were at work, as well as a number of his 4-cylinder *Jubilees*, one of which had appeared in 1897 as a 4-cylinder simple engine. These engines were doing fairly good work, but after 1900 the loads increased so rapidly as to outclass each type of engine almost as soon as it appeared, and in consequence a very large proportion of the express trains were double-headed.

No more startling change in motive power on a single road in such a short time could possibly be noticed than in this connection. No line has scrapped as many types of express engines during the past six years as the Northwestern. The old single-wheelers, and all the 3-cylinder passenger compounds, except three of the *John Hicks*, are no more; many of the 2-4-0 *Precedents* have disappeared; a number of the 4-cylinder compounds have been radically altered, and two at least have been rebuilt as simple engines. As all of these engines have since been replaced some idea may be obtained of the enormous outlay which this purely experimental work entailed, but the London and Northwestern owns 2,967 locomotives; its authorized capital is $653,865,603, and its revenue is $75,523,519, so it readily found the money.

It is interesting in this connection to note that although the Northwestern had for years at the head of its locomotive department Mr. Webb, the staunchest adherent of the compound principle, it was practically in the lead to dispense with compounding, and now all British locomotive engineers appear to regard the compound with disfavor, at least for passenger trains. It is quite true that the records of valuable experiments and tests made on many English roads definitely prove that compounding gives an appreciable, though small, saving in freight, and presumably for slow and heavy passenger trains, but they certainly yield no encouragement for fast express work.

The repudiation, or at least the seeming failure of compounding in Great Britain, and there only among foreign countries, is a puzzle certainly difficult to explain. All over Europe we find compounds—especially of the 4-cylinder balanced type—employed for trains at all speeds, including some with 60 miles per hour start to stop runs, with various loads over all kinds of gradients, sometimes very heavy ones. The same is true in India where "de Glehn" engines are reported to be doing splendid work in both freight and passenger service.

It is of interest to discover that recent Great Western practice shows that the success of some French and other engines is due not to the fact that they are compounds, but rather to certain other admirable features. The "de Glehn-du Bousquet" locomotives were the first engines which combined the perfect balance of four cylinders with ample boiler space, large heating surface and very high steam pressure. When tried on the Great Western they gave satisfaction in most ways, but one drawback was soon apparent; the steam entered the low pressure cylinders in a state which owing to the fall in pressure and temperature was little better than water, and after doing its work there more of it was exuded as liquid than went off through the exhaust. In other words, the weak point of these admirable compound engines was their compounding!

Of course, compound engines would gain quite as much and probably more in economy through superheating than simples do; therefore the above mentioned defect in the "de Glehn" would be lessened thereby, and if a re-heater could be fitted between the high and low pressure cylinders it might be cured altogether. But, though no doubt this could be done, there is the bugbear of back pressure to be faced, which such a contrivance seems bound to increase. If compounds be finally abandoned in British practice for express work the writer believes from his observations that back pressure will be the count on which they are condemned.

The thought occurs that the opposition of the locomotive runners to the compound engines had probably as much to do with their failure in England as the same spirit practically defeated their purpose in this country. The writer knows that the old 4-cylinder type (not Mallets) had few friends on the Baltimore and Ohio, the Erie and other roads with which he has been connected, and although the comment was not so audibly expressed on the other side it was amply in evidence. With the locomotive the engineer is a main factor. If you have the most powerful and efficient locomotive that can be produced, a big difference will appear in performance and efficiency according to whether the engineer is skilful, but above all whether he is in sympathy and accord with the device at hand. An engineer on the Midland railway explained to the writer that notwithstanding the proverbial care taken of all locomotives in England he scarcely had the compound assigned to his run for three days in the week. The principal trouble was with cylinder packing and metallic packing blows, and while these were being periodically repaired he was given a spare compound in not so good condition. Since a simple engine has been placed on the run he made 189 consecutive days with it, 206 miles every day.

It would be interesting to know whether Mr. Bowen-Cooke is of the same mind that he was some ten years ago, when in his lucid and instructive book he advocated general compounding, and highly praised the principle as applied by Mr. Webb, then his chief on the Northwestern. He may have been right, as it does not follow that the late superintendent's failure, any more than M. de Glehn's success, was wholly due to compounding. Mr. Cooke is now in a position to make his own experiments in the light of much new experience, and avoiding his former chief's mistakes may yet design an engine which will vindicate the compound principle, although the latter is certainly fast becoming a dead letter in the United Kingdom.

It is difficult to fully explain the unpopularity of compounding, but two important factors must be mentioned. The favor of the compound locomotive on the continent is partially due to the necessity for obtaining a low pressure exhaust, so that the fire is not torn to pieces. In England, however, with better coal, that factor does not so much apply, and the majority of locomotive superintendents find it better in the end to trust the engineers to work their engines to the best advantage, without any of the restrictions which compounding may impose upon manipulation of the engine.

The compounds become supplanted on the London and Northwestern by what are known as *Precursors* and *Experiments*, the first of which was turned out of the Crewe works in 1904. These engines have inside cylinders 19 in. x 26 in. They are of the 4-4-0 type, with driving wheels 6 ft. 9 in. diameter, steam pressure 175 pounds; heating surface 2,009 sq. ft., and grate area 22.4 sq. ft. The *Experiment*, 4-6-0 type, left the Crewe works in May, 1905, and are of the following dimensions: cylinders, 19 in. by 26 in.; driving wheels, 75 in.; boiler pressure, 175 pounds; heating surface, 1,970 sq. ft., and grate area, 25 sq. ft. The total weight of engine and tender in working order is 102.75 tons. These engines are called upon to work loads far above anything regularly encountered on any other main line in England, although, of course, at a lower speed and over an easier road than the Great Western.

For instance, they are regularly employed on the West Coast Scotch express, which makes the 406 miles from London to Glasgow in 8 hours and 15 minutes, averaging about 50 miles an hour from start to finish. On this run engines are changed at Rugby, Crewe and Carlisle, the latter change being from the Northwestern to the Caledonian, which engine takes it the remaining 103 miles to Glasgow without a stop in 114 minutes.

Some features worthy of mention are the length and width of the coaches, of which eight generally compose this train. They are 65 feet, 6 inches long, and 9 feet wide, the entire length of the train over buffers being 556 feet. This complete train, which includes two dining cars, is vestibuled throughout, with side aisles or corridors, and weighs about 380 tons. It was built at Wolverton in 1908 and constitutes a radical departure from the former English type of carriage. The train is steam-heated on the direct system, there being a controlling valve in each compartment, enabling the passengers to regulate the temperature. The luminant employed is electricity generated on Stone's system.

As may be appreciated from the above brief description of a famous run, the *Precursors* and *Experiments* are efficient engines. Three hundred and eighty tons hauled at a speed often exceeding 72 miles an hour is no mean performance, and these trains are marvels of punctuality, but even after all this good showing Mr. Cooke is not resting, because these successful engines were designed by the late Mr. Whale, and he is planning a daring type of his own. These will be 4-6-2 tank type, and the writer designates the idea as daring as it seems rather inconsistent to put up a tank engine on such a scale. Unfortunately the dimensions were not obtainable when the writer was at Crewe, but it appears that the tanks will hold about 1,700 gallons of water, and the coal capacity of the bunker will be about three tons. It is a matter of little moment how much the tanks contain as the Northwestern is replete with track troughs, but there is not much appeal in the small capacity of the coal bunker. However, engines are changed frequently, as has been mentioned, the longest stretch being from Crewe to Carlisle, 140 miles, and they may be able to get through.

Tank engines for some reason not apparent to the writer are becoming tremendously popular in that country in all classes of service, although none have been yet evolved on the ambitious lines proposed by Mr. Cooke. They do splendid work on the suburban and shorter runs, but, from an American viewpoint, the design scarcely appears consistent for long and hard non-stop service. The writer observed one of these recently on the Brecon and Merthyr railway which being typical in its dimensions is worthy of some special mention. It was one of four, of the 0-6-2 type built by Robert Stephenson & Co., Ltd., of Darlington, to the design of the Locomotive Superintendent of the above road, Mr. James Dunbar, for working heavy mineral traffic. The test performance, which the writer was fortunate enough to witness, consisted in the hauling of 11 ten-ton freight cars, fully loaded, and a brake van up a grade of 1 in 40. The principal dimensions of this engine were as follows: cylinders, 18½ in. by 26 in.; coupled wheels, 4 ft. 6 in.; radial wheels, 3 ft. 6 in.; fixed wheel base, 15 ft. 3 in.; total wheel base, 21 ft. 9 in.; heating surface, tubes, 1,296 sq. ft.; heating surface firebox, 120 sq. ft.; total heating surface, 1,416 sq. ft.; grate area, 21 sq. ft.; working pressure, 175 pounds. The adhesive weight in working order is 54 tons, 6 cwt., and the total weight 67 tons. The tanks have a capacity of 1,740 gallons, and the bunkers will accommodate 3 tons of coal. These engines are fitted with automatic vacuum brake so that they can be used, if necessary, in working passenger trains.

It is impossible within the confines of a single article to make full mention of the vast strides which have been made on all of the railroads of England, and some little prominence was given to the London and Northwestern because the writer believes it to be one of the greatest and most progressive lines in the United Kingdom. Its management has not been handicapped by blind adherence to ancient ideals which has characterized many of the others. It was the first to abolish, or practically abolish, the time-honored side door compartment carriage in favor of the much more sensible corridor car, and although the corridor is on the side and the compartments exist as of yore, the train can be traversed from end to end, and it is only a question of time before the aisle will be found in the center of the car as in our practice. In the through service the Northwestern was the pioneer in abolishing the second class carriage and improving the third to at least equal the second, and many of the remaining trunk lines are fast following in the wake of this improvement.

The writer has no intention of asserting that the next few years will bring about a revolution in favor of American standards on English railroads, but the trend seems to be certainly in that direction. Caste lines have been largely eliminated, to which the new arrangement of the cars mutely attests, and many of the old traditions have been rudely shattered. This is noticeable in the slow but sure growth in favor of the outside cylinders; fairly comfortable cabs in lieu of the former wind shields, and a much more simple arrangement of the cab fittings. Although in connection with the latter feature there is still much to be absolutely condemned, the fact remains that the improvement which only a few years has brought about is startling.

It was noticeable in the Crewe shops, and in the Swindon works, that far less money is thrown away in repairs than was formerly the practice. The definition "thrown away" is about the only real measure of the situation, because pedestal binders were actually planed, put into a vise and draw-filed and polished, and bolt heads under the engine where no one could possibly see them had their hexes filed to a gauge and polished. This has all been sensibly dispensed with, and no doubt the money saved in classified repairs put to a better purpose. The resentment which formerly prevailed against equalizers has largely disappeared. The writer recalls that on a former visit to England in 1899 he did not notice a single set of equalized driving springs. He spoke to Mr. John McIntosh, Locomotive Superintendent of the Caledonian at that time, regarding the omission of this very useful device, but it appeared that the perfection of the roadbed was considered sufficient to warrant hanging the springs independently. There are many equalized engines in England at this writing. The engineers of the London, Brighton and South Coast say that the riding of the engines has been improved fifty per cent., and the records of the running sheds or roundhouses show a diminished application of springs of about one hundred per cent. The mention of these things is simply to emphasize the presence of the wave of common sense reform which, although long delayed, we have all felt some day would sweep over English railroad practices.

What the future will bring forth can only be conjectured, but the writer firmly believes that the British locomotive of 1920 will be as far removed from what is running there now as the *Precursor* of to-day is from the Webb compound of 1900. There will be eleven cars before long on the Scotch expresses, as there are frequently now on the American boat train specials. The economics of present day administration discountenance the splitting of trains into sections with the resultant double expense, and insist on adequate power to move them as a single unit. This may explain why midnight oil is now being burned in the motive power offices of the great railroads where only a short time ago after hours they were as gloomy as the tombs.

So many elements enter into the making of success or failure of an express engine under twentieth century conditions of speed and load, that it needs long trial and much investigation to settle which are the exact things that make an engine's work good or bad. For example, with the old D slide valves the latest Swindon engines would never have given the results which they now yield; piston valves, giving a big opening for a small movement of the valve itself, are essential with exhaust ports of 10 inches in the two cylinder engines, or 8 inches in the 4-cylinder ones; and it is just these big ports and a free exhaust throughout, that makes them such remarkably speedy machines.

Mr. Churchward designed these engines, both in Atlantic and six-coupled form, which preserved all the good points of the "de Glehn" and another, viz., the Walschaert valve gear, but they are "non-compounds." These were cheaper to build and also proved most economical engines in actual working. It was thought at first that 225 pounds of steam must be wasteful when used only once, but worked with an early cut-off in very long cylinders, this has not proved so in practice. Under any conditions they were found able to do all, and rather more, than the "de Glehns" had done, at least in England, and at less cost. One special advantage claimed for the "de Glehn" was that at starting, or when a special effort was needed on a hill, live steam could be sent into the big low-pressure cylinders. The Swindon 4-cylinder engines, however, working without this advantage, give wonderful up-hill speeds, rising to 67 miles an hour on a grade steeper than 1 in 200, with a good average load.

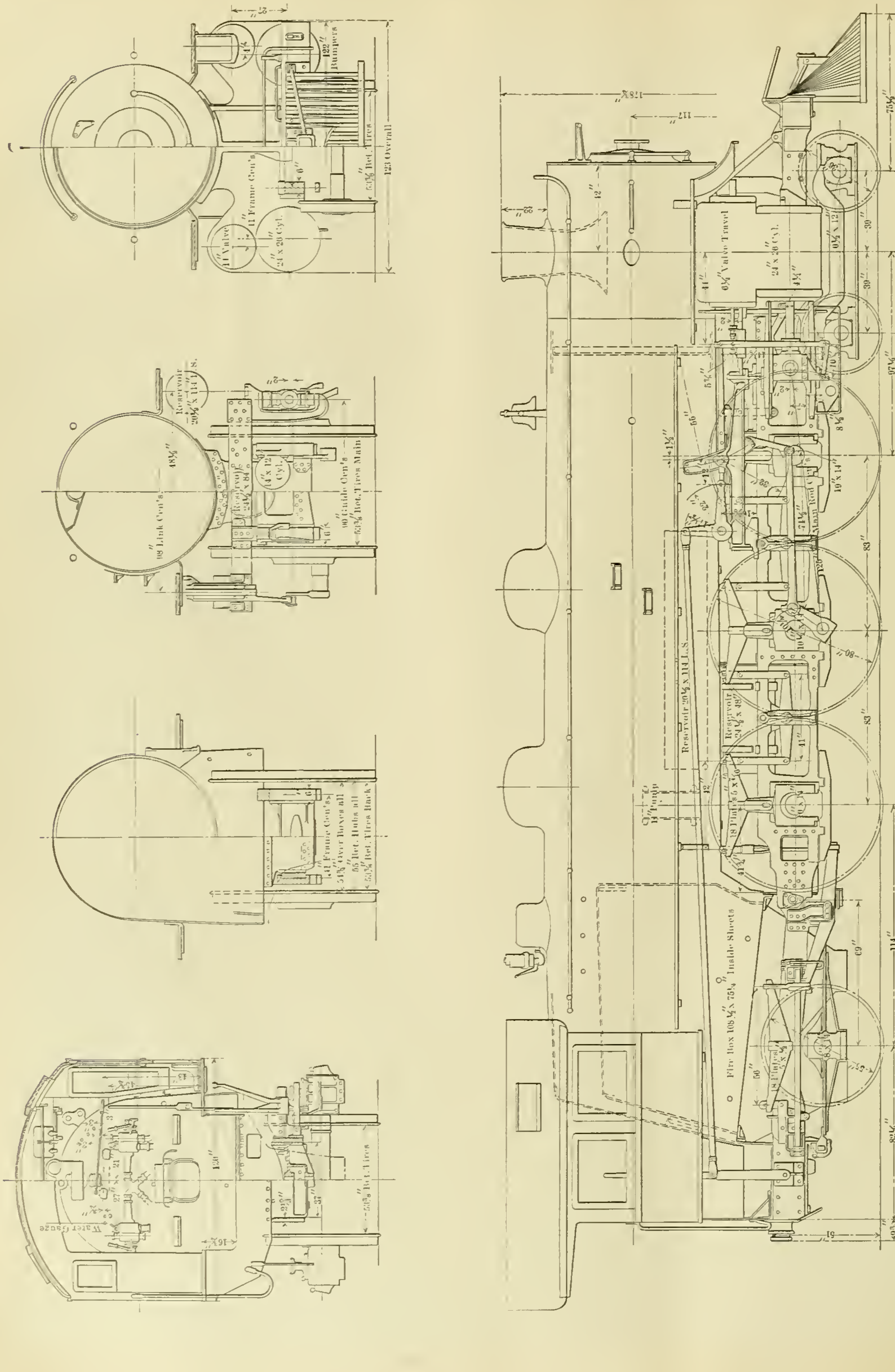
Some time ago there was considerable discussion relative to the advisability of lowering the pressure on the "super-heated" 6-coupled engines of the Great Western, but this project has been finally abandoned and the original pressure will be maintained. No doubt the combination of so high a pressure with hot and quite dry steam does mean the drying up of oil when that is supplied in the ordinary way. It was quite in evidence in connection with some of the 2-8-0 class on the Great Western and on one of these engines the pressure was lowered by about 20 pounds and it proved a distinct gain, but for fast passenger work the "spring" in high pressure steam is of unquestioned value, and with their usual ingenuity the Swindon works staff have met and overcome the lubrication difficulty They are now fitting a jet of (wet) steam, which as the inlet valves open discharges a spray of oil into the cylinder. It is thought that wherever the steam is blown a drop of oil is also carried, and this means a complete lubrication of the piston's path as it moves at every stroke.

The ingenuity displayed by its motive power men prestiges well for the future of the English locomotive. Much has been done, but much more remains, and the present is the crucial period. It is unfortunate that more uniformity of ideas does not prevail among the various designers such as might be secured by the presence of an association of scope corresponding with the American Railway Master Mechanics, and doubly unfortunate that so much money has been needlessly spent on weird types of engines which scarcely had even an experimental value.

It is now largely realized, however, that simplicity and general reliability are far more important features than refinements of design, and special devices can rarely be employed. It is known that the heavy corridor train from a novelty has now become an institution, and it is appreciated that the 4-6-0 or 4-6-2 type is the most efficient to handle it with economy and with dispatch. The ground thus narrowed down to a working basis, for passenger service at least, effectually eliminates the single driver freaks and other monstrosities which got along fairly well when the carriages were shells and five of them made up a train, but admit of no more comparison with the modern locomotives of the Great Western to-day than a hansom does with a taxicab. The British traveler, although not inclined to be unduly critical, now demands something vastly better than his presumed to be adequate facilities of a decade ago, and the management of the various railroads are sincere in their intention to give it to him without the sacrifice of one solitary minute of running time; hence the outcome is awaited in much curious expectancy by those who have made any study of the situation.

Motor Control for Machine Tools.—Equally important with the choice of motors is that of control. In selecting the control it is necessary to consider the nature of the work, its accessibility to the operator, the method of attaching it to the tool and in some cases its relative position to other tools; for instance, an open type starting rheostat should not be exposed to danger of short-circuit from flying chips. In the majority of cases, a shunt motor of ¾ h. p. and less would be started by a switch. Exceptions to this would be motors on tools that must be gotten under way slowly, and grinders driven by direct-current motors for reasons of safety. With adjustable-speed motors, care should be taken to throw the switch on full field. Series motors up to 8 h. p. or even larger can be started by switch. Exceptions to this would be cranes and tools requiring a certain amount of armature speed regulation. Larger motors, for tools where starting service is infrequent or not severe, and for lineshafts and for group drivers, would be satisfactorily operated with a dial type controller, which is cheaper than the drum controller, provided, however, that the controller is placed in a protected position.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

Leather Belting.—Single belts will stand a stress of 60 pounds per inch of width with occasional taking up and will have a fairly long life, provided the pulleys are not too small. The permissible stress for double and triple belts is 105 and 150 lbs., respectively.



POWERFUL PACIFIC TYPE LOCOMOTIVE FOR THE VANDALIA.

Heavy Pacific Type Locomotives

VANDALIA LINE.

Until recently an Atlantic type locomotive having a total weight of 185,000 lbs., weight on drivers of 107,500 lbs., cylinders 21 x 26 in., and a maximum tractive power of 24,650 lbs., has been the standard class of passenger locomotive used on the Vandalia Line. During the past few years, however, the requirements in passenger service have increased to such an extent that a heavier locomotive than can be provided in the Atlantic type is now needed to handle certain of the trains. In consequence, in ordering new passenger equipment from the American Locomotive Company in December, 1909, it was decided to include four heavy locomotives of the Pacific type to be used on some of the most important trains.

LOCOMOTIVE THAT PULLS A TWELVE-CAR TRAIN AT 65 MILES PER HOUR.

Prior to the advent of these engines, the Vandalia was one of the few important roads in the country on which the Pacific type locomotive had not been adopted for at least the most difficult passenger service. In fact, because of the favorable service conditions on this line, both the freight and passenger traffic have hitherto been handled altogether by the lighter classes of motive power. The Mogul type of engines is at present the standard class for freight service, and the equipment includes the heaviest examples of this type so far constructed. The last Mogul engines built for this road by the American Locomotive Company had a total weight of 187,000 lbs., 159,300 lbs. on driving wheels, 21 x 28 in. cylinders, and a maximum tractive power of 33,300 lbs.

The engines here illustrated have now been in service for two months on the St. Louis Division. Although designed for fourteen car trains, they have not up to date had occasion to handle more than twelve cars to a train. Officials of the road report that the service with the trains of that size have been very satisfactory and gives every indication that there will be no difficulty in meeting the more severe requirements which will be put upon them in the winter time. In their report, the officials make particular mention of the easy riding qualities of the engines, stating that they ride remarkably well at a high rate of speed (60 miles per hour and upward). They are operating under easy grade and curvature conditions. There are, to be sure, a number of portions of the road of from three to ten miles long where the curves are numerous; but the sharpest curve on the division is only 3 deg. 48 min., and there are long straightaway stretches with very few curves.

As to the grades, the total rise between St. Louis and Summit, a distance of 217.8 miles, is only 474 ft. This rise, which is against eastbound traffic, is accomplished by a series of short, easy ascents over rolling territory with long stretches of practically level track in between. Practically the only grade of any consequence against eastbound traffic lies between Reelsville and Almeda, Ind., where in a distance of approximately 8 miles, the total rise is 216 ft., giving an average gradient of 0.503 per cent. Going in the other direction, the grade conditions are still easier, there being several long, easy slopes in favor of westbound traffic.

The following table gives a record of eight typical runs of some of the most important trains between Indianapolis and Terre Haute, and the latter place and St. Louis:

Train	Date.	Terminals of Run.	Dist. Mi.	No. of cars.	(Tons) Tot. wt. train, incl. eng	Sched. time, incl. stops	Run. time, incl. stops	Tot. water used. Gals.	Approx Tot. coal used. lbs.	Coal used per hr. lbs.	Lbs. of coal sq. ft. grate area pr. hr.	Highest. speed M H.P.	Exhaust tip Diam.	Remarks.
21	7-12 10	Indpls. to Terre Haute.	73	10	800	1 hr. 42 min.	1 hr. 40 min.	5700	7000	4200	74.5	60	6″	Eng. steamed poorly. Indiana coal, heavy rain.
14	7-13 10	Terre Haute to Indpls.	73	10	825	1 hr. 50 min.	1 hr. 50 min.	5700	7000	3818	67.5	60	6″	Indiana coal.
21	8-3 10	Indpls. to Terre Haute.	73	12	825	1 hr. 42 min.	1 hr. 46 min.	6000	7000	3965	70.2	65	6¼″	Indiana coal.
14	8-4 10	Terre Haute to Indpls.	73	11	875	1 hr. 50 min.	1 hr. 48 min.	5700	5200	2885	51.0	60	6¼″	Indiana coal, heavy fog and mist
21	8 4 10	Indpls. to Terre Haute.	73	8	715	1 hr. 42 min.	1 hr. 34 min.	5100	6000	3830	67.8	65	6¼″	Indiana coal, fine and dirty, heavy quartering wind.
7	8-12 10	Terre Haute to St. Louis.	175	7	650	4 hrs. 30 min.	4 hrs. 13 min.	12400	13000	3065	54.6	75	6¼″	Indiana coal.
20	8-13 20	St. Louis to Terre Haute.	175	8	740	4 hrs. 11 min.	4 hrs. 11 min.	14200	15500	3720	65.9	75	6¼″	Hard Running Train Ill. Coal.
21	8-18 10	Indpls. to Terre Haute.	73	9	710	1 hr. 42 min.	1 hr. 36 min.	5900	6000	3750	66.3	75	6¼″	Indiana coal, rain and quartering wind.

When the engines were first put into service it was necessary to make some minor changes in the front end arrangement, which was the Vandalia standard. After that the engines steamed freely and no trouble was experienced.

"Schedule Time" and "Running Time" in the above table includes in each case all stops. Trains 21 and 14 between Indianapolis and Terre Haute make three and two regular stops, respectively. While between Terre Haute and St. Louis train No. 7 makes four regular stops, and train No. 20 three. From this table it is apparent that these engines have no difficulty in maintaining the train schedules.

An examination of the figures for the coal consumption indicates that the engine was not pushed to the limits of its capacity on any of the runs. From this table it will be noticed that the highest rate of coal consumption per square foot of grate area per hour (which was calculated from the data furnished by the railroad company) is only 74.5 lbs. The figures for the total amount of coal used per trip, in view of the tonnage and speed maintained, are also very creditable.

Although the design incorporates no new or unusual features, it is an excellent example of a straightforward, well proportioned design carefully worked out to meet the particular conditions of service for which the engines were intended. That the engines are well adapted to meet the requirements, is shown by the train records in the above table. The design is entirely new and follows in general the builders' standard practice.

As far as the cylinders and running gear are concerned, it is practically identical with the engines of the same type built by the American Locomotive Company for the Pennsylvania Railroad,* the use of which on the Vandalia road was prohibited by the limit of 55,000 pounds for the allowable load per driving exle. The principal differences between the two designs are a reduction of the boiler pressure from 210 to 200 lbs. and use of a smaller boiler and firebox, the boiler of the Vandalia locomotive being 76½ in. in diameter outside at the first ring; while this dimension in the Pennsylvania locomotives is 79¾ in. The boilers of both locomotives are of the straight top type, and the tubes in each case are 21 feet long.

In regard to the firebox, that of the engines here illustrated is 108⅛ in. long by 75¼ in. wide, having a grate area of 56½ sq. ft.; while that of the Pennsylvania locomotive is 111 in. long by 80¼ in. wide, and has a grate area of 61 8/10 sq. ft.

These modifications in design result in a reduction of 14,000 lbs. in the total weight of the locomotive. The Vandalia engines have a total weight of 256,000 lbs. as compared with a total weight of 270,000 lbs. for the Pennsylvania locomotives.

Although the reduction of 10 lbs. in the boiler pressure reduces the maximum tractive effort of the engines here illustrated 2,600 lbs., as compared with that of the locomotive built for the Pennsylvania, at 60 miles per hour there is only 600 lbs. difference between the tractive efforts of the two locomotives calculated in accordance with the builders' formula.

The general design is shown in the accompanying illustrations and the general dimensions and principal ratios are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	31,800 lbs.
Weight in working order	256,000 lbs.
Weight on drivers	162,000 lbs.
Weight of engine and tender in working order	401,900 lbs.
Wheel base, driving	13 ft. 10 in.
Wheel base, total	35 ft. 2½ in.
Wheel base, engine and tender	66 ft. 5 in.

RATIOS.

Weight on drivers ÷ tractive effort	5.10
Total weight ÷ tractive effort	8.05
Tractive effort × diam. drivers ÷ heating surface	580.00
Total heating surface ÷ grate area	77.50
Firebox heating surface ÷ total heating surface, per cent	4.43
Weight on drivers ÷ total heating surface	37.00
Total weight ÷ total heating surface	58.50
Volume both cylinders, cu. ft	13.60
Total heating surface ÷vol. cylinders	322.00
Grate area ÷ vol. cylinders	4.15

CYLINDERS.

Kind	Simple
Diameter and stroke	24 x 26 in.

VALVES.

Kind	Piston
Diameter	14 in.
Greatest travel	6½ in.
Outside lap	1¼ in.
Inside clearance	⅛ in.
Lead at 6½ in. cut off	¼ in.

WHEELS.

Driving, diameter over tire	80 in.
Driving, thickness of tire	4 in.
Driving journals, main, diameter and length	10½ x 14 in.
Driving journals, others, diameter and length	10 x 14 in.
Engine truck wheels, diameter	36 in.
Engine truck, journals	6½ x 12 in.
Trailing truck wheeels, diameter	55 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	76½ in.
Firebox, length and width	108⅛ x 75¼ in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	383—2 in.
Tubes, length	21 ft.
Heating surface, tubes	4,195 sq. ft.
Heating surface, firebox	194 sq. ft.
Heating surface, total	4,389 sq. ft.
Grate area	56½ sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	14 ft. 10¾ in.

TENDER.

Tank	Waterbottom
Frame	10 and 12 in. channels
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7,500 gals.
Coal capacity	12 tons

* See American Engineer, July, 1907, p. 267.

THE STANDARDIZATION OF MOTOR DRIVES FOR MACHINE TOOLS.

At the Rochester convention of the National Machine Tool Builders' Association the Committee on the Standardization of Motor Drives for Machine Tools made a report of progress of its negotiations with the committee of the American Association of Electric Motor Manufacturers. Seven points have been agreed upon, but the final adoption of the new standard practice by the two associations has not yet come up for formal action. The schedule as agreed upon is as follows:

1. *Horsepowers.*—It is thought that the following horsepowers will meet practically all the requirements of electric drives for machine tools: 1, 1½ (for D. C. only), 2, 3, 5, 7½, 10, 15, 20 and 25. Though it was agreed that horsepowers more than 25 and less than 1 are used, it was not thought advisable to embody them at the present in the attempted standardization, but it was held out that they might be embodied some time in the future among the standardized sizes.

2. *Voltage.*—It is recommended that for D. C. motors 115 and 230 volts be adopted as standard, and for A. C. motors 110 and 220 volts.

3. *Horsepower Ratings for Drives.*—It is recommended that the horsepower ratings for machine tool drives be the standard ratings of the American Association of Electric Motor Manufacturers—*i. e.,* (a) that motors be given the continuous constant horsepower rating where approximately standard load conditions exist; (b) for adjustable speed motors used for intermittent service the standard two-hour continuous duty rating be used for ordinary shop conditions, and that the name plates of such motors indicate the time as well as horsepower ratings of the motor, and further that the horsepower be figured at the high as well as the low speed for adjustable speed service.

4. *D. C. Motors.*—It is the recommendation of the joint committee that constant speed motors, adjustable speed with a range of 2 to 1, and adjustable speed motors with a range of 3 to 1, be included in the attempt at standardization. It is the opinion that this will cover practically all the requirements of the majority of machine tool manufacturers, and these ratios are recommended for the guidance of tool and motor designs.

This does not exclude the occasional use of motors with a different speed range, such as 4 to 1, or even more, but it was the opinion of the committee that motors with a higher range of speed than 3 to 1 are not used to a sufficient extent and are not so absolutely necessary for machine tool construction, as to include them among the standardized motors.

5. *Speeds.*—The following table of speeds is recommended as the standard for adjustable speed D. C. motors:

Hp.	2 : 1	3 : 1
25	900—450	900—300
20	900—450	900—300
15	1,200—600	1,200—400
10	1,200—600	1,200—400
7½	1,200—600	1,200—400
5	1,200—600	1,200—400
3	1,500—750	1,500—500
2	1,500—750	1,500—500
1½	1,500—750	1,500—500
1	1,500—750	1,500—500

The tendency of the electrical manufacturers is of course toward higher speed motors, but it was thought desirable by the committee to hold out for lower speeds, on account of mechanical difficulties in gear and chain driving when higher speeds are used. The schedule as given above is a compromise, and will allow of motor drives with reasonable linear speed of first driving gears, and limits the number of revolutions of the motor to within the limits given by chain makers for the proper speed of their chains.

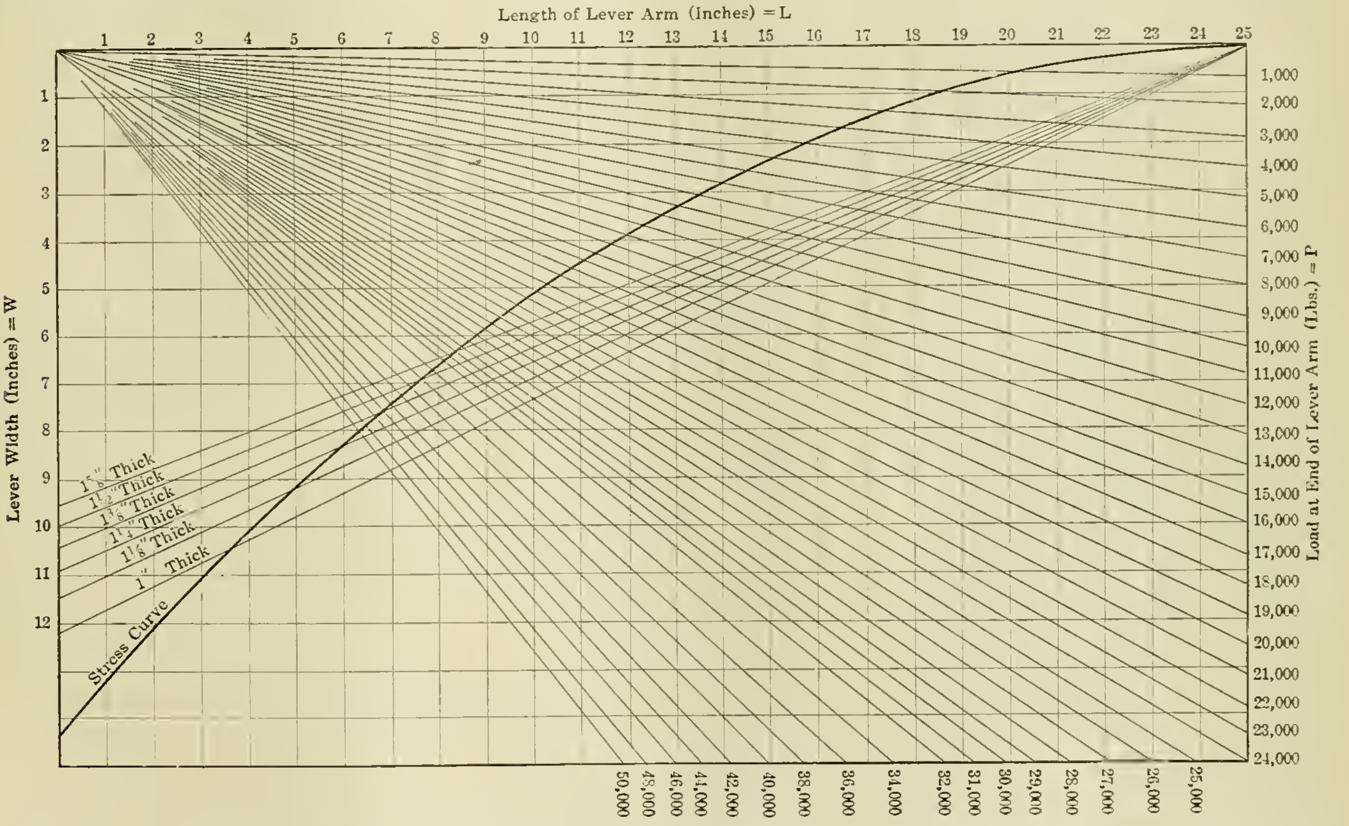
6. *A. C. Motors.*—It is recommended that the following table of polyphase 60-cycle A. C. motors be adopted:

25 hp	900 and 600	5 hp	1,200
20 hp	900 and 600	3 hp	1,200
15 hp	900 and 600	2 hp	1,200
10 hp	1,200 and 600	1 hp	1,800 and 1,200
7½ hp	1,200 and 900		

7. For the consideration of the constant speed A. C. motors, 60 cycles is to be used as the basis.

DESIGN OF BRAKE LEVERS.

A chart for the determination of the width and other features of brake levers devised by Fred. W. Pennington, Westinghouse Air Brake Co., appeared in the June issue of the *Air Brake Magazine,* and is reproduced below. With this diagram it is possible to quickly obtain the width through the middle pin hole when the forces on the lever, the thickness, and the distance between pin centers are determined. The thickness should be such that the bearing pressure between lever and middle pin shall not exceed 23,000 lbs. per sq. in. (M. C. B.).



The following example will illustrate the use of the diagram: Assuming a lever 1 in. thick with arms 20 in. and 15 in. in length, and forces at the ends of the arms, 7,500 and 10,000 lbs. respectively; first, locate the line at the right of the diagram corresponding to the force of 10,000 lbs. and follow this line to its intersection with the vertical line, 15 in.; then move horizontally to the "stress curve," moving vertically from this point to the line marked "1 in. thick." By following a horizontal line through this point to the left side of the chart, the lever width is found to be 6¼ in. The same result, of course, would be obtained by using the force, 7,500 lbs. and 20 in., the corresponding length of arm.

In case the arm of the desired lever is greater in length than 25 in., which is the limit of the diagram, this length should be divided by 2 and the corresponding force multiplied by 2 before proceeding as shown in the above example. In this diagram the effect of the pin hole on the strength of the lever is neglected.

Motor Car for Southern Railway.—The Southern Railway Company is having built a McKeen motor car which will have an extreme length of 72 feet 10 inches, and will be divided into four compartments, one to accommodate the engine, the baggage and express room, and two passenger compartments designed for the separation of the races, one having a seating capacity of forty and the other of eighteen. These compartments will have separate entrances, and each will have its own lavatory, water cooler, and other conveniences. The body of the car is of all steel construction, of torpedo design.

Intelligent Workmen Cause No Trouble.—The more intelligent our workmen are, the less trouble they will give us. It is the floating element which causes trouble. The really skilled mechanic wants to rise on his own ability and when he sees that the manufacturer gives him the opportunity to better himself, by showing individual effort, he is apt to become a persistent and loyal member of the organization under which he is working.—*B. M. W. Hanson before the Hartford Mfrs.' Assoc.*

Locomotive Performance on Grades of Various Lengths*

IT IS GENERALLY RECOGNIZED AMONG PRACTICAL OPERATING MEN THAT LOCOMOTIVES SEEM TO DECREASE IN POWER OR GET TIRED ON VERY LONG GRADES. THE AUTHOR INVESTIGATES THE CAUSES OF THIS CONDITION AND DETERMINES THE POINT OR DISTANCE ON THE GRADE WHERE THIS GENERALLY OCCURS

By Beverley S. Randolph.

While engaged in such studies some years ago the attention of the writer was attracted by the fact that the usual method of calculating the traction of a locomotive—by assuming from 20 to 25 per cent. of the weight on the drivers—was subject to no small modification in practice.

In order to obtain a working basis, for use in relation to this feature, he undertook the collection of data from the practical operation of various roads. The results are given in Table 1, from which it will be seen that the percentage of driver weight utilized in draft is a function of the length as well as the rate of grade encountered in the practical operation of railways.

In this table, performance will be found expressed as the percentage of the weight on the drivers which is utilized in draft. This is calculated on a basis of 6 lb. per ton of train resistance, for dates prior to 1880, this being the amount given by the late A. M. Wellington, M. Am. Soc. C. E.,† and 4.7 lb. per ton for those of 1908-10, as obtained by A. C. Dennis, M. Am. Soc. C. E.,‡ assuming this difference to represent the advance in practice from 1880 to the present time. Most of the data have been obtained from the "Catalogue of the Baldwin Locomotive Works" for 1881, to which have been added some later figures from "Record No. 65" of the same establishment, and also some obtained by the writer directly from the roads concerned. Being taken thus at random, the results may be accepted as fairly representative of American practice.

Attention should be directed to the fact that the performance of the 10-30 E, Consolidation locomotive on the Lehigh Valley Railroad in 1871 is practically equal to that of the latest Mallet compounds on the Great Northern Railway. In other words, in the ratio between the ability to produce steam and the weight on the drivers, there has been no change in the last forty years. This would indicate that the figures are not likely to be changed much as long as steam-driven locomotives are in use. What will obtain with the introduction of electric traction is "another story."

Item No.	Length of grade, in miles.	Rate of grade.	Maximum curvature.	Compensation.	Gross weight of load, in tons.	Weight of tender, in tons.	Weight of locomotive, in tons.	Weight on drivers, in tons.	Percentage of weight on drivers utilized in draft.	Class.	Maker.	Railroad.	Year.	Source of Data.	Remarks.
1	0 06	0.056	......	....	115	..	37.5	29	0.330	8-28⅓ C	Baldwin.	Morgan's Louisiana & Texas...........	1880	Baldwin Catalogue, 1881, p. 134	
2	0.33	0.0203	25° 20'	....	242	25	35	23	0.285	8-28 C	"	Long Island.........	1878	" " 1881, " 72	10 miles per hour.
3	1.0	0.06	16°	0.05	192	22	57.5	50	0.310	10-36 E	"	Atchison, Topeka & Santa Fe..........	1879	" " 1881, " 115	8 " " " Stops and starts on grade.
4	1.3	0.0127	......	....	600	16	40	32.5	0.300	Mogul.	"	Chillan & Talcahuana................	1879	" " 1881, " 100	
5	1.4	0.0128	3°12'	....	750	15	51	44	0.270	10-34 E	"	Chicago, Burlington & Quincy.........	1880	" " 1881, " 116	Stops and starts at any point on grade.
6	2.0	0.01	......	....	1 000	15	51	44	0.291	10-34 E	"	Chicago, Burlington & Quincy	1880	" " 1881, " 116	
7	2.2	0.013	3°	....	725	15	51	44	0.245	10-34 E	"	Chicago, Burlington & Quincy.........	1880	" " 1881, " 116	
8	2.5	0.0144	6°	....	400	27	42	32	0.237	10-32 E	"	St. Louis & San Francisco	1879	" " 1881, " 87	
9	2 5	0.004	......	....	2 700	70	96.7	85.8	0.207	H 6 - A	Pa. R.R.	Cumberland Valley.	1910	....	
10	3.5	0.033	14°	....	100	25	35	35	0.160	....	....	....	....	Trautwine's Pocket Book, Ed. 1882, p. 412....................	Empty cars; many curves and reversions.
11	3.6	0.035	10°	0.05	236	22	57.5	50	0.245	10-36 E	Baldwin.	Atchison, Topeka & Santa Fe..........	1879	Baldwin Catalogue, 1881, p. 114	
12	4 0	0.0085	4°	....	1 020	30	51	44	0.256	10-34 E	"	Missouri Pacific.....	1880	" " 1881, " 112	
13	6 0	0.0145	......	....	308	25	38	28	0.207	10-28 D	"	Western Maryland.	1878	" " 1881, " 86	12 miles per hour.
14	6.0	0.020	10°	0.05	460	32	57.5	50	0.242	10-34 E	"	Atchison. Topeka & Santa Fe.........	1879	" " 1881, " 114	8 " " "
15	7.5	0.002	......	C	6 152	86	134 5	109.5	0.243	Mallet.	"	Virginian Ry........	1910	*Engineering News*, Jan. 13. 1910.	
16	9.75	0.018	......	....	200	18	29	29	0.170	....	....	Pennsylvania	....	Trautwine's Pocket Book, Ed. 1882, p. 412..................	
17	10 0	0.006	......	C	6 173	86	299	265	0.203	Mallet.	Baldwin.	Virginian Ry........	1910	*Engineering News*, Jan. 13, 1910.	Road locomotive and helper.
18	12 0	0.018	10°	....	280	30	51	44	0 160	10-34 E	"	Lehigh Valley, Wyoming Div.........	1871	Baldwin Catalogue, 1881, p. 112	
19	12.0	0.022	......	....	850	74	175	156	0.166	D-D 16	"	Great Northern.....	1908	Baldwin Loco. Wks. Record, No. 65, p. 29......................	
20	13.0	0.022	......	....	800	74	177	158	0.153	D-D 1	"	Great Northern.....	1908	Baldwin Loco. Wks. Record, No. 65, p. 23.................	
21	13.0	0.022	14°	....	415	50	91	83	0 154	Consol.	"	Baltimore & Ohio...	1910	....	Very crooked line. Uncompensated.
22	16.0	0.0044	......	....	9 500	30	51	44	0.164	10-34 E	"	Central of N. J......	1880	Baldwin Catalogue, 1881, p. 113.	
23	20.0	0.022	......	....	500	62	97.5	90	0.170	F-8, Consol.	"	Great Northern.....	1908	Baldwin Loco. Wks. Record, No. 65, p. 29.................	
24	20.0	0.022	......	....	800	74	177	158	0.159	L-1, Mallet.	"	Great Northern.....	1906	Baldwin Loco. Wks. Record, No. 65. p. 23.................	

TABLE 1.

These results have also been plotted and are presented in Fig. 1, with the lengths of grade as abscissas and the percentages of weight utilized as ordinates. The curve sketched to represent a general average will show the conditions at a glance. The

* From the Proceedings of the Amer. Soc. Civil Engineers, April, 1910. The paper, of which a liberal extract is here given, was not presented at any meeting.
† "The Economic Theory of Railroad Location," 1887 Edition, p. 502.
‡ *Transactions*, Am. Soc. C. E., Vol. L, p. 1.

results may at first sight seem irregular, but the agreement is really remarkable when the variety of sources is considered; that in many cases the "reputed" rate of grade is doubtless given without actual measurement; that the results also include momentum, the ability to utilize which depends on the conditions of grade, alignment, and operating practice which obtain about the foot of each grade; and that the same amount of energy due to momentum will carry a train further on a light grade than on a heavy one.

There are four items in Table 1 which vary materially from the general consensus. For Item 9, the authorities of the road particularly state that their loads are light, because, owing to the congested condition of their business, their trains must make fast time. Item 10 represents very old practice, certainly prior to 1882, and is "second-hand." The load consisted of empty coal cars, and the line was very tortuous, so that it is quite probable that the resistance assumed in the calculation is far below the actual. Items 15 and 17 are both high. To account for this, it is to be noted that this road has been recently completed, regardless of cost in the matter of both track and rolling stock, and doubtless represents the highest development of railroad practice. Its rolling stock is all new, and is probably in better condition to offer low resistance than it will ever be again, and there were no "foreign" cars in the trains considered. The train resistance, therefore, may be naturally assumed to be much less than that of roads hauling all classes of cars, many of which are barely good enough to pass inspection. As the grades are light in both cases, this feature of train resistance is larger than in items including heavier grades. Attention should be called to the fact that a line connecting the two points representing these items on Fig. 1 would make only a small angle with the sketched curve, and would be practically parallel to a similar

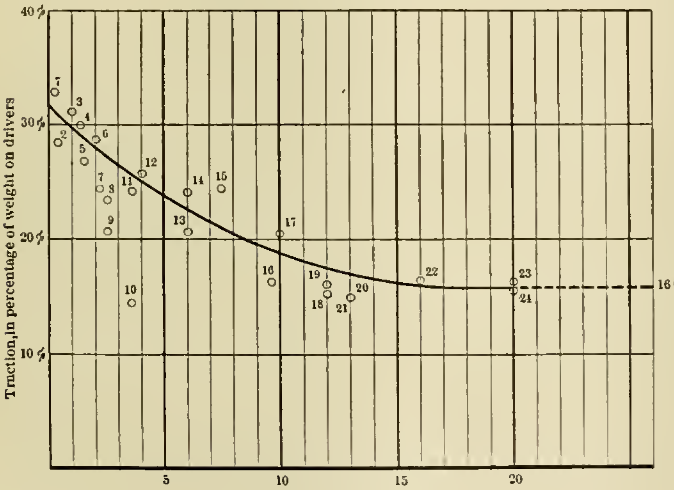


FIG. 1.

line connecting the points represented by Items 13 and 16. There is, therefore, an agreement of ratios, which is all that needs consideration in this discussion.

Wellington, in his monumental work on railway location, presents a table of this character. The percentages of weight on the drivers which is utilized in draft show the greatest irregularity. He does not give the length of the grades considered, so that it is impossible to say how far the introduction of this feature would have contributed to bring order out of the chaos. In his discussion of the table he admits the unsatisfactory character of the results, and finally decides on 25 per cent. as a rough average, "very approximately the safe operating load in regular service." He further states that a number of results, which he omits for want of space, exceeds 33 per cent. The highest shown in Table 1 will be found in Item (0.06 mile, 0.066 grade), showing 33 per cent. There is no momentum effect here, as the grade is a short incline extending down to the river, and the start is necessarily a "dead" one. The reports of Item 3, which shows 31 per cent., and Item 5, which shows 27 per cent., state specifically that the locomotive will stop and start the loads given at any point on the grade.

The results of a series of experiments reported by A. C. Dennis in his paper, "Virtual Grades for Freight Trains," previously referred to, indicate a utilization of somewhat more than 23 per cent., decreasing with the speed.

All this indicates that the general failure of locomotives to utilize more than from 16 to 18 per cent. on long grades, as shown by Table 1, can only be due to the failure of the boilers to supply the necessary steam. While the higher percentage shown for the shorter grades may be ascribed largely to momentum present when the foot of the grade is reached, the energy due to stored heat is responsible for a large portion of it.

When a locomotive has been standing still, or running with the steam consumption materially below the production, the pressure accumulates until it reaches the point at which the safety valve is "set." This means that the entire machine is heated to a temperature sufficient to maintain this pressure in the boiler. When the steam consumption begins to exceed the production, this temperature is reduced to a point where the consumption and production balance.

The heat represented by this difference in temperature has passed into the steam used, thus adding to the energy supplied by the combustion going on in the furnace. The engines, therefore, are able to do considerably more work during the time the pressure is falling than they can do after the fall has ceased.

The curve in Fig. 1 would indicate that the energy derived from the two sources just discussed is practically dissipated at 15 miles, though the position of the points representing Items 16, 18, 19, 20 and 21 would indicate that this takes place more frequently between 10 and 12 miles. From this point onward the performance depends on the efficiency of the steam production, which does not appear to be able to utilize more than 16 per cent. of the weight on the drivers. The diagrams presented by Mr. Dennis in his paper on virtual grades, and by John A. Fulton, M. Am. Soc. C. E., in his discussion of that paper, indicate that similar results would be shown were they extended to include the distance named.

From this it would appear that a locomotive is capable of hauling a larger train on grades less than 10 miles in length than on longer grades, and that, even when unexpectedly stopped it is capable of starting again as soon as the steam pressure is sufficiently built up. Conversely, it should be practicable to use a higher rate of ascent on shorter grades on any given line without decreasing the load which can be hauled over it. In other words, what is known as the "ruling grade" is a function, strictly speaking, of the length as well as the rate of grade.

Shops Not Attractive to Educated Boys.—There does not seem to be any unity of action throughout the country to produce more mechanics in a systematic way, and too little earnest thought has been given to make the machine shops in particular attractive to the American educated boy. One of the chief reasons, I believe, is that the wages offered to an apprentice boy under modern conditions are entirely too low, and we often get our labor supply from the emigrant office and the street instead of from the graduating class of the American schools.—*B. M. W. Hanson before the Hartford Manufacturers' Association.*

Test Your Steam Gauges Regularly.—There was a recent locomotive boiler explosion in the yards of the National Lines of Mexico at Monterey, killing nine men, including the engineer and the night roundhouse foreman. The entire firebox end was blown off, shearing the double row of rivets in the barrel of the boiler, the crown sheet being torn across, and the fire box and outer shell were found 100 yards away. The boiler was built in 1897, but the sheets were apparently in good condition. It is generally believed that the cause was excessive pressure, as it is known that the steam gauge was out of order, and perhaps the safety valves also.

How Burning Screenings Affected the Shop Output---and Why.

IN A SHOP WHERE THE MACHINES ARE ALL BELTED TO A LINE SHAFT, ANY VARIATION IN THE SPEED OF THE SHAFT IS OF COURSE ACCOMPANIED BY A CORRESPONDING VARIATION IN THE OUTPUT OF THE TOOLS. IN ONE SHOP THE SUBSTITUTION OF SCREENINGS FOR LUMP COAL IN THE POWER PLANT REDUCED THE LINE SHAFT REVOLUTIONS OVER 26 PER CENT. THE AUTHOR EXPLAINS THE CAUSE AND HOW IT WAS CORRECTED.

By V. T. K.

A certain locomotive repair shop has in its power house four return tubular boilers rated at 100 horsepower each. Lump coal had been burned under these boilers up to last winter, when an order came that thereafter screenings would be furnished exclusively. A change to finer grates was the only alteration made in the boilers.

A fair trial soon made it clear that with this fuel the boilers would not furnish sufficient steam to run the plant to its full capacity. The line shaft of the machine shop had been running 208 revolutions a minute, but now the boilers at the very best would only furnish sufficient steam to run it 160; in fact, when the peak load came on it often dropped as low as 95 revolutions a minute. A careful study of the whole plant soon revealed the trouble, which proved to be where the average head of a locomotive repair shop would hardly look for it.

In the first place, it was found that the boilers had been working under a load above that of their rated capacity before the change in coal took place. From the records it is known there was 3,904 lbs. of coal burned per hour under the boilers previous to the change in coal. The ordinary grades of coal obtained were of the cheap variety, having a heat value of only 10,430 B. t. u. per pound. Steam at 150 lbs. gauge contains 1,194 B. t. u. per pound. Allowing 60 per cent. boiler efficiency there will be evaporated $(10430 \times 60) \div 1194 = 5.24$ pounds of water per pound of coal as fired giving $(3904 \times 5.24) \div 30 = 683$ boiler horsepower developed by that amount of coal. The boilers, therefore, have been worked 70 per cent. over their rated capacity.

The grate area of the four boilers, as first installed, was 140 square feet, but this was subsequently shortened by some one that thought he knew what he was about. Probably he heard somewhere that by reducing the grate area a hotter fire could be had, but lost sight of the fact that the draft must be increased in order to force the required supply of air through the reduced grate area, which in this case could not be obtained unless the stacks were made higher or some mechanical draft resorted to. The air space between fingers of the grates was 36 square feet, and after the alteration of the grate, 28 square feet; the area had been altered just the opposite to what it should have been. The draft in the furnace before the change in fuel had been .31" of water and the corresponding velocity in feet per second 35, while, after the change to the fine coal the draft was .18" of water and the corresponding velocity 25 feet per second. The amount of air entering the furnace through the grates before the change amounted to $35 \times 60^2 \times 36 \times .60 = 2{,}721{,}600$ cu. ft. per hour, and after the change it was 1,307,840 cu. ft. per hour; the amount of air required for complete combustion of that amount of coal should be $3904 \times (34 \div .0747) = 1{,}776{,}320$ cu. ft. per hour, that reduced the draft power

$$\frac{1{,}776{,}320 - 1{,}307{,}480}{1{,}776{,}320} = 26\%$$

Consequently the boiler horsepower was reduced in the same proportion, or

$$683 \times .26 = 177 \text{ H.P.}$$

And also the speed of the line shaft in the machine shop would be reduced to $208 - (208 \times .26) = 154$ rev. per min., which comes close to what the average speed actually was.

Now, these figures are theoretical; the actual supply of air to the furnace through the grate was a good deal less at times, as was evidenced by the speed of the line shaft falling off to 95. This can be accounted for with the reasoning that the screenings did not have a heat value of 10,430 B. t. u., and that over 60 per cent. of the screenings being nothing but fine coal dust, which packs very readily, closing up the air space, thereby decreasing the number and the size of the voids in the bed of fire to practically nothing at the instant the fire was being fed, and not until the volatile matter had been distilled off enough to render the solid matter porous, did the air gain access to the furnace.

The result of this condition in the power house, which of course was corrected as soon as it was definitely located, was to increase the time and cost of the whole output of the shop in the same ratio. A machine job which previously had taken an hour would take about 15 minutes longer and cost 46¼ cents instead of 38 cents. A locomotive which was scheduled for 15 days would require 19 days unless overtime was resorted to. The actual results did not always show just this variation, as the shop was not exactly balanced, but the general effect was to increase the time and cost about 26 per cent.

STEAM TURBINE ELECTRIC LOCOMOTIVE.

On the main lines of the Caledonian and North British Railways, a steam turbine electric locomotive, built for this company by the North British Locomotive Co., Ltd., from the designs of Mr. Hugh Reid, has recently undergone preliminary trials. This locomotive was briefly described by Mr. Reid in his presidential address to the Glasgow University Engineering Society of last year, as follows:

"Steam is generated in a boiler of the ordinary locomotive type, which is fitted with a superheater, and the coal and water supplies are carried in the side bunkers and side water tanks at both sides of the boiler. The steam from the boiler is led to a turbine of the impulse type running at a speed of 3,000 revolutions per minute, to which is directly coupled a continuous-current variable voltage dynamo. The dynamo supplies current and pressures varying from 200 to 600 volts to four series-wound traction motors, the armatures of which are built on the four main or driving axles of the locomotive. The exhaust steam from the turbine passes into an ejector condenser ,and is, together with the circulating condensing water, delivered eventually to the hotwell. As the steam turbine requires no internal lubrication, the water of condensation is free from oil, and consequently is returned from the hotwell direct to the boiler by means of a feed pump. The water evaporated by the boiler is therefore returned to the boiler again and again, and the supply of water carried in the tank is actually circulating water for condensation purposes. This condensing water is circulated within practically a closed cycle by means of small centrifugal pumps driven by auxiliary steam turbines placed alongside the main turbine and dynamo. The cycle of the condensing water is from the tanks through the first pump, then through the condenser, where it becomes heated in condensing the exhaust steam, then to the hotwell. From the hotwell it passes through the second pump to the cooler, situated in front of the locomotive, where the full benefit of the blast of air caused by the movement of the locomotive, aided by a fan, is utilized for cooling the hot circulating water. After passing through the cooler, the water is returned to the supply tanks ready for further service.

"The condensation of the exhaust steam deprives the locomotive boiler of the usual exhaust blast which induces the draft through the fire-box and boiler tubes. In the experimental locomotive the induced draft is replaced by forced draft provided by means of a small turbine-driven fan. The fan is placed within the cooler, so that it will deliver hot air to the boiler fire, and at the same time assist the current of air through the cooler. The small switchboard and the instruments required, the controller for grouping the four motors in series—series parallel and parallel, according to the draw-bar pull to be exerted—and the regulator for controlling the voltage in the electrical circuit, and consequently the speed of the train, are all placed on the driver's platform within easy reach.

"The foregoing comprises the main and auxiliary machinery of this experimental locomotive. The whole is mounted upon a strong underframe, which is carried upon two eight-wheeled compound trucks so constructed that they will easily negotiate curves. Each truck carries two of the four driving motors already referred to. As the engine is intended for express passenger main line work, it is hoped to obtain comparisons from its actual working with the performances of the reciprocating steam locomotives, especially as regards the relative consumption of fuel and water, and also as to the efficiency of transforming the energy of steam into draw-bar or train pull, as well as the relative rapidity of acceleration under the old and new systems.

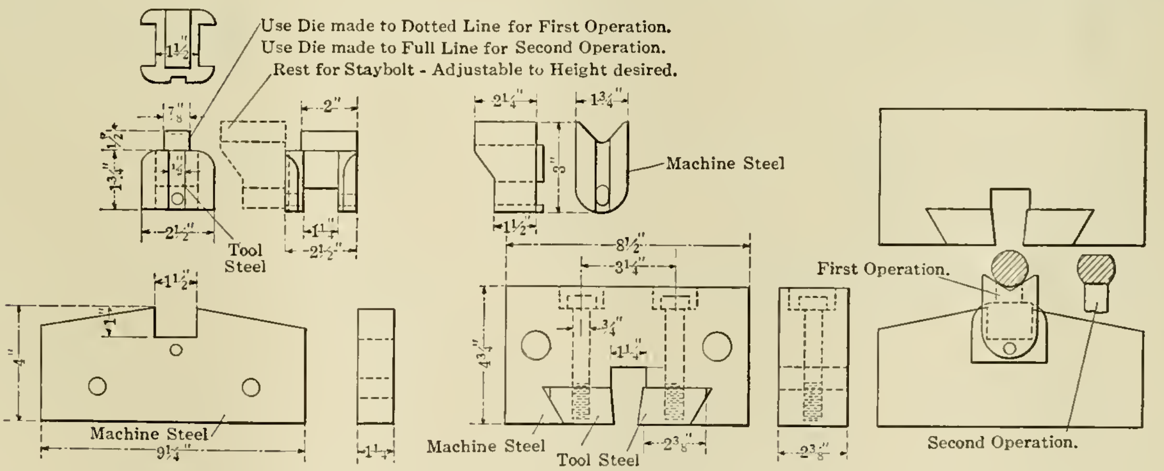
"Most of the component parts of this steam turbine electric locomotive have already proved themselves effective and efficient in other applications, and the novelty lies in the combination of the different elements of which the locomotive is composed. The expected results in this case should not, therefore, be so problematical as in an invention where the novelty is in the details, and it is the question of the cost of the locomotive which most troubles the patentees or raises any doubt as to its free adaption. It is only when the attempt is made to substitute an electric for a steam locomotive that we realize at what a very moderate first cost the steam locomotive can now be produced in up-to-date establishments with modern machinery and scientific organization in comparison with any arrangement involving the use of expensive electrical apparatus."

DIES FOR SHEARING SQUARES ON STAYBOLTS.

At the Readville shops of the New York, New Haven & Hartford Railroad a set of dies have been devised for application to a Hilles & Jones No. 2 shear, which permits the cold shearing of the squares on the ends of staybolts being done in a very rapid and satisfactory manner.

Two sides of the squares are sheared in the first operation by cutters of small inserted tool steel pieces set into a head of the proper shape, which is secured to the shear head. These cutters are 2⅜ in. in length and are set apart the proper distance for the squares desired. Of course, the length of the square can be anything desired up to the length of the cutters. On the lower plate of the shear is a holder for steadying the bolt during the operation, which is provided with two styles of support, one for cutting the first two faces, which is hollowed out to fit the round part of the bolt, and the other flat on top to insure the faces being at 90 degs. and used when cutting the other faces.

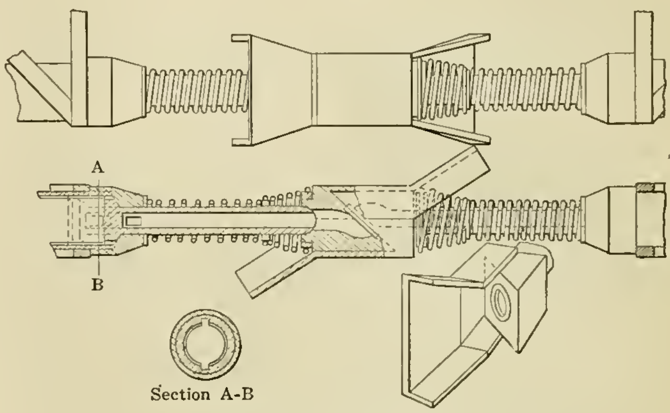
With this arrangement the ends of 100 staybolts can be squared in an hour.



DETAILS OF DIES FOR SHEARING SQUARE ENDS ON STAYBOLTS.

AUTOMATIC AIR HOSE CONNECTOR.

A new design of automatic air hose connector has been patented by Howard W. Thomas, of Charleroi, Pa., that differs in many particulars from any of the designs now existing. Reference to the illustration will readily show the general features of this arrangement, which uses the trough scheme for centering the head and an inclined face for the abutting connectors. This connector also automatically closes off the air when uncoupled



AUTOMATIC HOSE CONNECTOR.

and in many particulars is the lightest and simplest arrangement that has been designed.

In its essential features it consists of a tubular stem guided by a flange on the end of the train pipe, this stem having an enlarged end guided inside of the train pipe by two lips sliding in grooves, to prevent its turning, which acts as a stop and also as a valve for closing off the air. When this stem is forced in sufficiently, ports in its side permit the passage of air from the train line. It is held outward by a coil spring resting between the end of the train line and the flange screwed to the stem. At its other end it has a ball joint connection to the head, allowing the latter to move freely in any direction, although the spring which holds the head in place tends to keep it central. The head includes the trough guide which has a horizontal face for a short distance, then inclines at an angle of 45 degs. outward, the perspective view showing this arrangement very clearly.

The whole apparatus, except the heads, is rigid, being supported by a hanger from the coupler shank and all vertical or lateral motion is taken up by the ball joints of the head.

DROP BOTTOM GONDOLA CAR WITH A NEW ALL STEEL TRUCK.

DROP BOTTOM GONDOLA CAR WITH A NEW CAST STEEL TRUCK.

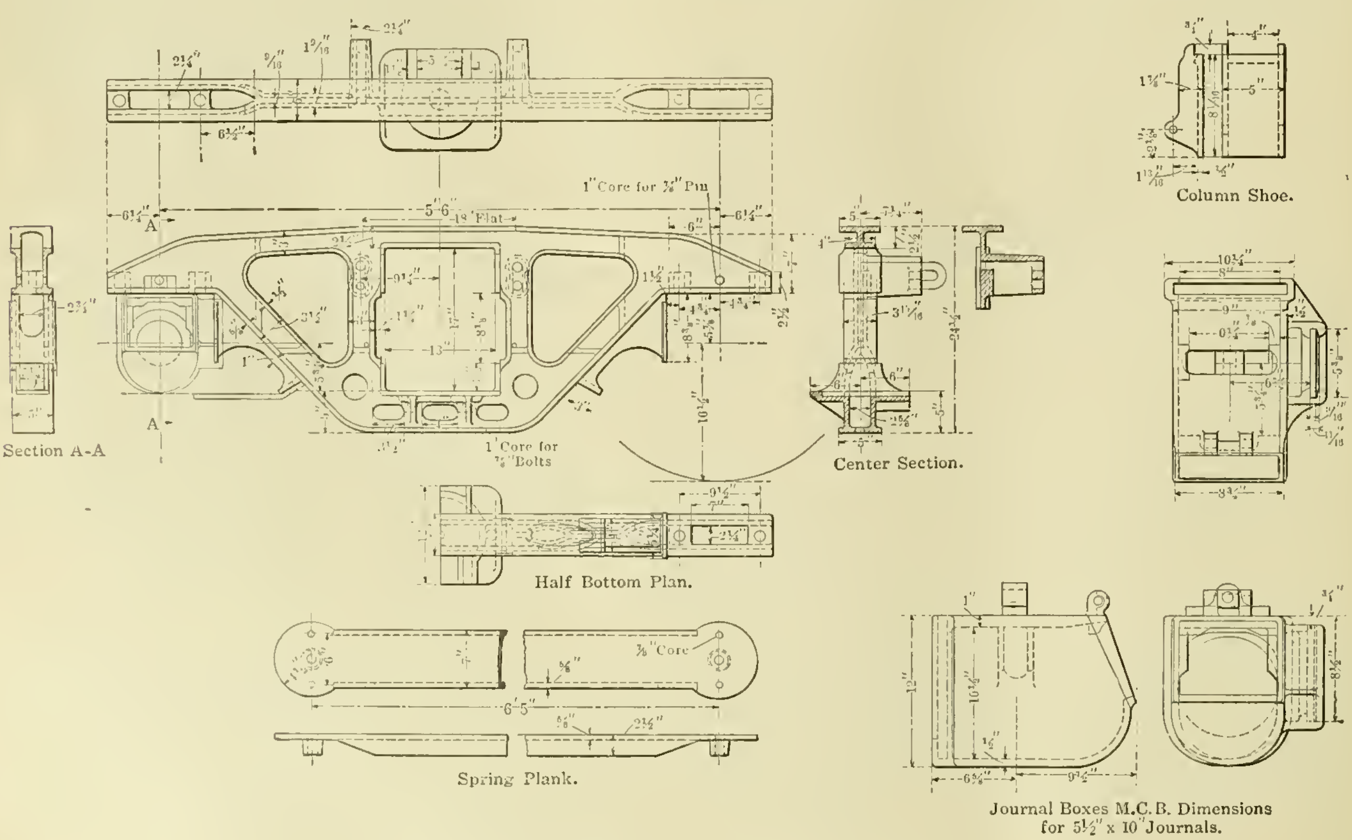
The Western Steel Car & Foundry Co. has recently completed for the Gilmore & Pittsburgh one hundred 50-ton composite gondola cars of the general service type. These cars have a single center sill with a trussed side frame built up of standard sections for the tension and special sections for the compression members. The floor consists of 10 drop doors covering the full length of the car and arranged to discharge the load at the sides. The doors on either side may be operated independently and it requires but three or four minutes to discharge the whole load and close the doors. The ends are arranged to drop inward, so that the car can be used for loading long material.

Under these cars a truck is used which, in addition to having a cast steel side frame and bolster, has also cast steel journal boxes and a cast steel spring plank. The truck frame contains no bolts, although the journal boxes are cast separate from the side frame. Provision is made in the frame for the application of column bolts and a tie bar in case it becomes necessary to apply an ordinary malleable or cast iron journal box for temporary repairs. On the side frame, the details of which are clearly shown in the line drawing, are included wings with an extension face, over which a recessed extension on the inside of the journal box fits. On top of the journal box is a lug that extends up through an opening in the side frame and a ⅞ in. pin slips through both and holds the box in place, no other fastening being provided. At the bottom of these wings are extensions, to which a temporary tie bar can be secured when necessary.

On the cast steel spring plank there are two lugs, one on either end, 2½ in. in diameter and 1⅞ in. deep, that set into cored openings at the bottom of the side frame. These lugs are tapered and provide the necessary fastening between the lower sections of the two side frames. The spring plant is a steel casting of channel shape with the wings cut away at the ends, as shown in the illustration.

On the columns of the side frames, removable filler blocks or cheek plates have been provided. These cheek plates permit the bolsters to be placed or removed without jacking up the car or taking out the spring plank, and they also take a considerable portion of the service wear from the truck side frame column faces. This construction is an invention of W. P. Richardson, mechanical engineer, Pittsburgh & Lake Erie Railroad.

This truck is manufactured by the Pittsburgh Equipment Co., House Bldg., Pittsburgh, Pa.



DETAILS OF THE NEW STEEL TRUCK USED UNDER THE ABOVE CAR.

The general dimensions of these cars are as follows:

Height from rail to top of body	8 ft. 11 in.
Height from rail to top of floor	4 " 7 "
Depth of car body	4 " 4 "
Length inside of body	41 " 9 "
Length over end sills	43 " 2⅝ "
Width inside of body	9 " 2½ "
Width over side stakes	10 " 2 "
Length of drop door openings, 4 doors	4 " 9 "
12 doors	4 " 10 "
Width of drop door openings	4 " 0½ "
Distance from center to center of trucks	31 ft.
Truck wheel base	5 ft. 6 in.
Capacity	50 tons
Weight	41,803 lbs.
Ratio of paying freight to total weight loaded car	72.5 per cent.

Special equipment used is as follows:

Brakes	Westinghouse
Brake beams	Damascus, Waycott
Couplers	Climax
Coupler operating device	Carmer
Draft rigging	Westinghouse friction
Nut locks	Bartley

SERVICE OF CONVERTED MALLET LOCOMOTIVE.

GREAT NORTHERN RAILWAY.

About a year ago the Great Northern Railway converted a large consolidation locomotive into a Mallet compound by the removal of the front truck and the addition of an entire new front unit, furnished by the Baldwin Locomotive Works. This made a locomotive of the 2-6-8-0 type, which has since been in service hauling ore from the mines at Kelly Lake to the docks at Allouez, just outside of Superior. The consolidation locomotive was previously in the same service and handled 70 cars of average 63 tons each, or a total tonnage of 4,410 beind the tender. This service was performed with a consumption of 10 lbs. of coal per 100 ton miles. The converted locomotive is handling 6,615 tons or 105 cars with an average consumption of 7 lbs. of coal per 100 ton miles, or but a slightly greater total coal consumption with 50 per cent. greater tonnage.

The original consolidation locomotive had the following general dimensions:

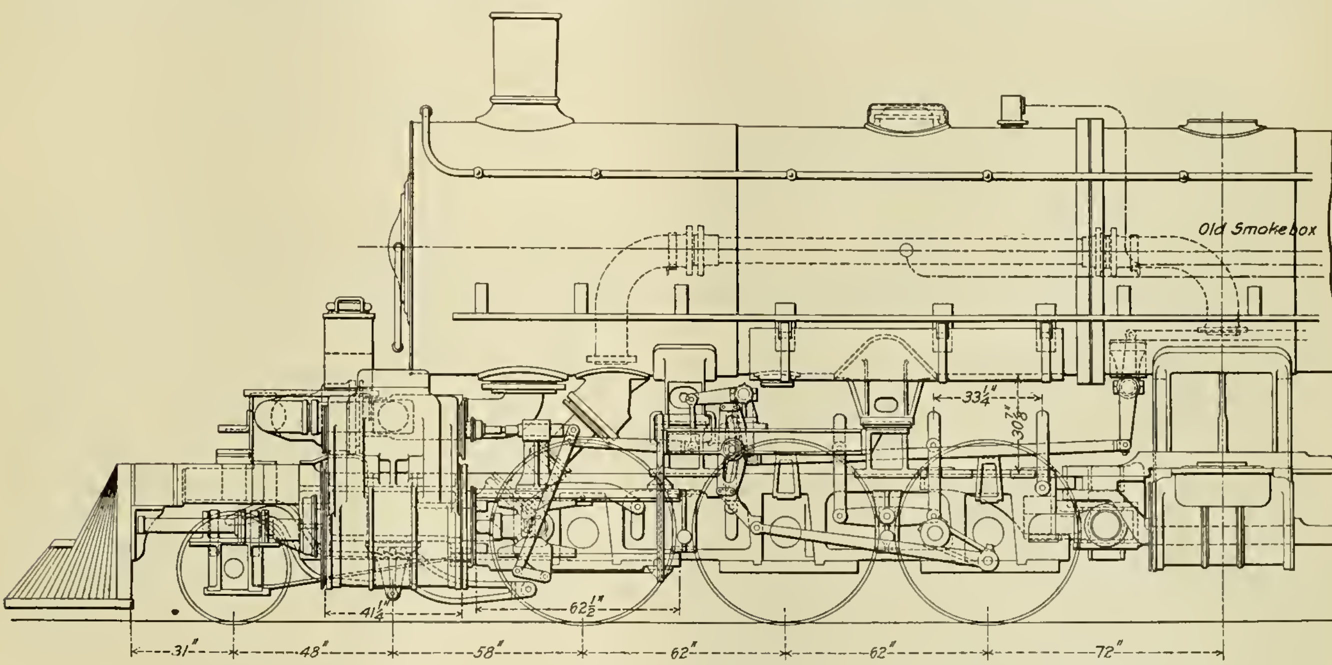
Cylinders	20 in. x 32 in.
Driving wheels, diameter	55 in.
Boiler, diameter	74⅛ in.
Steam pressure	210 lbs.
Total heating surface	2,727 sq. ft.
Grate area	59 sq. ft.
Wheel base, driving	16 ft.
Wheel base, total	24 ft. 3 in.
Weight on driving wheels	188,250 lbs.
Weight total engine	210,350 lbs.
Tractive effort	41,500 lbs.

The front truck, bumper beam and pilot were removed and applied complete to the new front unit. A steel casting was inserted in front of the cylinders to carry the pivot pin for connecting the front group and the exhaust pipe was removed, the openings being covered by a cast iron elbow pipe that terminated in a horizontal receiver pipe passing through the center of the feed water heater, which was carried in the new extension of the boiler. The stack opening was closed with a suitable cover.

In the boiler an Emerson fire tube superheater was installed, which a later test showed to give as high as 626 degs. F. at the high pressure cylinders.

Over the front group is carried the feed water heater and an extension smoke box. An internal ring is riveted to the shell just back of the feed water heater and a similar ring was secured to the smoke box of the old locomotive, these two rings being bolted with a V-shaped fit and held together by horizontal bolts in the same manner used for other separable boilers built by the Baldwin Works. The feed water heater has 346 2-in. tubes, 8 ft. long, giving a heating surface of 1,451 sq. ft. The flue through which the receiver pipe passes is larger than the pipe itself, so that it acts somewhat as a reheater in itself.

The steam distribution on the new unit is controlled by 12-in. piston valves, operated by Walschaert valve gear. The high pressure cylinders were equipped with American Balanced Valve Company slide valves, and after the superheater was applied there was more or less trouble with the valves and seats cutting. These cast iron valves were finally replaced with a brass valve and the lubricant changed to the Galena Balanced Superheater valve oil, since which time there has been no trouble with the valves.



NEW FRONT UNIT APPLIED TO THE CONVERTED MALLET LOCOMOTIVE ON THE GREAT NORTHERN RAILWAY.

The driving wheel base of the new unit, as will be seen in the illustration, is 10 ft. 4 in. and its total wheel base 19 ft. 2 in. The total wheel base of the rebuilt locomotive is 45 ft. 8 in. and approximately 135,000 lbs. is carried on the forward group of driving wheels. Two supports, both of which normally have their surfaces in contact, carry the overhang of the boiler on the front group. Centering springs and clamps of the usual form are provided. The equalization of the forward unit is continuous on each side. Over the front driving box yoke equalizers are placed, from which are carried a transverse steel casting, which supports an inverted leaf spring. This spring is connected to the back end of the forward equalizers from the truck by a link.

The service with this experimental engine has been so satisfactory that it is probable other consolidations will soon be converted.

[ESTABLISHED 1832]
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CONTRIBUTIONS—Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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CONTENTS

* Illustrated articles.

ALL STEEL PASSENGER CARS

Steel car designers will be interested in studying the features of the underframe designed by the Pullman Co., which is shown in this issue. By a careful study this company has been able to develop a steel underframe which is not unduly heavy and is still perfectly suited and entirely interchangeable between practically all types of passengers cars.

It will be seen that this standard design is arranged to carry practically all of the load and transmit all buffing and pulling shocks through a large centre girder, being in this respect somewhat similar to the construction employed in the Pennsylvania steel car. The use of the large combination casting at the ends simplifies the whole design decidedly, although it would appear as if too many parts were included in this one casting. There would seem to be no objection to forming those parts, which are more lilable to become damaged, separately and bolt them to the main casting. In other respects the design presents practically nothing to criticize.

In the superstructure special efforts have been made to insure excellent insulation. This feature is a particularly important one on sleeping cars, and it is to be hoped that the schemes here employed will prove satisfactory in very cold weather.

While the designers of this car are to be congratulated in respect to its total weight it is quite probable that longer experience will bring out a number of points wherein they can be made still lighter. It is to be hoped that these steel cars will eventually weigh no more than the present wooden ones.

CONVERTED MALLET LOCOMOTIVE

About a year ago the Great Northern Railroad transformed a large consolidation locomotive into a Mallet compound engine simply by the addition of a new front group of wheels with a low pressure cylinder and an extension on the boiler, which contains a feed water heater. At the same time a high degree superheater was installed in the old boiler. In other respects the original boiler, as far as the steam generating section was concerned, was not altered. This new locomotive was put into service on the same section where the original consolidation was used, and the result is that by burning practically the same amount of coal about 50 per cent. greater tonnage is moved over the road. There is nothing particularly surprising in this result, which only checks the figures which have been obtained previously in other comparisons, but the interesting part is in the small cost at which this largely increased tonnage was obtained.

GENERAL EFFICIENCY

During the past few years there has been a remarkable advance in the design and construction of machine tools, and especially of those for use in railroad shops. However, this is but an instance of the future general improvement resulting from the heavier demands continually being made upon tool manufacturers by industrial as well as railroad shop people. This has already resulted in astonishingly high efficiencies which were never anticipated, even by the makers. It is only fair, however, to give a large part of this credit to the manufacturers of high speed steel who have made equally, or perhaps even more, remarkable progress. In fact, it is safe to say that the progress made in the design and construction of machine tools was, in a way, the result of the great advance that had been made in high speed cutting tools, and machine builders were influenced not only by the demands of the users of their products, but also by the necessity to keep pace with the rapid advance and improvement in the manufacture of high speed steel. Even at the present time, with the best designed modern machine tools it is doubtful if the full advantages of high speed steel are always being utilized or the great possibilities in efficiency completely realized.

The reduced operating cost of many railroad machine shops is undoubtedly due in a large measure to the activity and talent of machine tool builders and to the steel makers, but it is impossible to foretell the result in efficiency of a plant where we have a proper combination of machine tool efficiency or individual efficiency with rapid shop facilities and methods and also an efficient management. High individual efficiency is very rapidly reduced when the work is not planned properly or when there is a lack of proper facilities for handling material. The high total efficiency in output (of a shop) that could be realized with only a small amount of attention to planning the work properly and providing facilities, would be very surprising and much more than is usually supposed.

Probably one of the largest factors in the total efficiency of a shop is the proper location of tools or grouping of tools both to aid supervision and to save unnecessary handling of material. In addition to this, the proper output of machine tools and methods for obtaining this have a decided effect upon the establishment of the proper labor compensation which in turn has a direct bearing on the resulting general efficiency.

In many railroad shops, when a machinist becomes efficient after performing a number of repeated operations, his reward is sometimes a "cut" in the price on that particular work by the foreman of the department. As a result the machinist refuses to increase his efficiency further and he puts himself in the same class with the less skilled machinist, being practically forced to take this course by the management. This reduction of the efficiency of the good machinist has a depressing effect upon the general output of the shop, and many foremen do not realize that in cutting prices unnecessarily they are bound to reduce the output, possibly to a greater extent than the saving made by the cut, to say nothing of the ill feeling and discontent which must follow such actions, completely destroying all co-operation between the men and the foremen, and frequently also resulting in a variety of schemes on the part of the men to cheat the company out of all the time they possibly can.

The cause of this more or less general condition is principally a sad lack of knowledge in superintendents and foremen, of what should be a proper and reasonable output to demand from the men under various conditions. It is very unfortunate that there is a general lack of reliable information and data on this question and more especially on methods for arriving at this output.

Low Water Test of a Jacobs-Schupert Fire Box

WITH THE WATER LEVEL FROM 4 TO 6 IN. BELOW THE TOP OF THE CROWN SHEET, OIL BURNER GOING FULL BLAST, STEAM PRESSURE OF ABOUT 230 LBS., AND A TEMPERATURE OF THE CROWN SHEET AT OVER 1100 DEGS., A BOILER WITH A JACOBS-SCHUPERT FIRE BOX WAS FILLED WITH WATER AT 60 DEGS. TEMPERATURE IN A RECENT TEST.

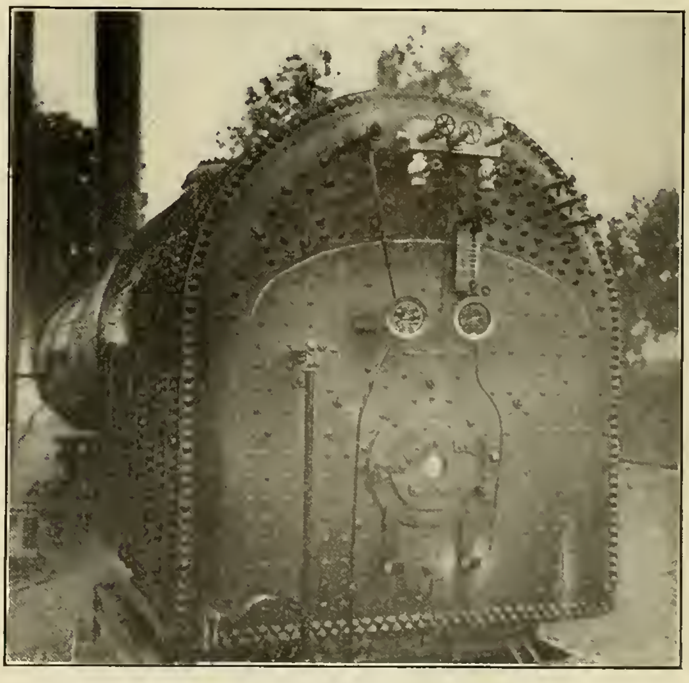
In the presence of a number of the mechanical officials of the Santa Fe Railroad, boiler inspectors, representatives of the Brotherhood of Locomotive Engineers and E. L. Gibbs, safety appliance inspector of the Interstate Commerce Commission, a test was made on September 26th to determine the effect of low water on a Jacobs-Schupert fire box.*

The boiler was of the standard design used on the Santa Fe type locomotives and had been in service in the stationary plant for about ten months. It was carefully mounted in an open space in the shop yard and equipped for burning oil. The oil burning equipment and other boiler appliances were the same as is used in regular locomotive service. In place of injectors a steam pump was connected for furnishing the feed water, this pump being located some distance from the boiler and operated by steam from the stationary plant, so that in case of anything happening to the boiler there would be no danger to the operator of the pump. The blow-off cock located in the front water leg was provided with apparatus so that it could be opened and closed from a safe distance. The supply of oil for the burner was also controlled from the same place.

On the back head of the boiler a line was drawn corresponding to the height and contour of the crown sheet, and in addition to the usual water glass a second water glass was placed at such a height that its top was level with the bottom of the other one. Behind this glass was a scale marked with large figures, which showed the distance of the level below the top of the crown sheet.

Pyrometers were arranged to indicate the temperature on the water side of the crown sheet and connections were made for the proper reading of the instruments in a thoroughly protected location near by. The steam gauges and water glasses were also visible from this same protected spot and here were stationed the spectators. A telescope permitted the accurate reading of the steam gauge and the water level.

The boiler was fired up in the usual manner and after the safety valves, which were set at 225 lbs. pressure, opened, the blow-off cock was opened with the fire still burning, and level of the water was lowered to a point 4 in. below the crown sheet. The blow-off cock was then closed, and the boiler remained in this condition for ten minutes with the oil burner operating at full pressure. During this time the safety valves were still blowing off and the evaporation brought the level down to 6 in. below the crown at the end of the test. The average steam pressure shown at the gauge during this time was 230 lbs. At the end of ten minutes the feed pump was started, the fire extinguished and water of 60 degrees temperature was pumped into the boiler, the pumping being continued until there was two-



BOILER READY FOR LOW WATER TEST.

* For full illustrated description of this design See American Engineer, March, 1909, p. 106.

thirds of a glass on the upper or regular water glass.

At the time the cold water was started the pyrometer registered 1,125 degrees at the front end of the fire box and 1,065 at

INTERIOR OF FIREBOX AFTER LOW WATER TEST. THE TUBES ARE WELDED IN THE SHEET BY THE AUTOGENEOUS PROCESS.

the rear end. Immediately after the test and while there was still steam pressure in the boiler several boiler inspectors entered the fire box and examined it closely. As is seen in the illustration, the photograph for which was taken immediately after the test, there is plain evidence of the metal having been heated to an exceedingly high temperature, but there is no sign of deformation, no bulging being evident, and the fire box as a whole was found to be in practically perfect condition.

This test reproduced the most severe treatment possible for a locomotive boiler and one under which the ordinary stay supported crown sheet would have undoubtedly failed. In addition to proving the superiority, under these conditions, of a fire box which employs no stay bolts it also checks the tests made a number of years ago by the Pennsylvania Railroad, in showing that there is no danger of explosion by putting cold water on to fire box sheets which have been overheated.

WHEEL ARRANGEMENT AND WHEEL STRESSES ON MALLET LOCOMOTIVES.

To the Editor:

In the first paragraph of the article on the Equalization of Mallet Articulated Locomotives, in your September issue, Mr. Johnston states that the practice of equalizing "all the driving springs of the front engine with the leading truck, if one is used, prevents local stresses of a diagonal nature on uneven track, or when entering or leaving curves on which the outer rail is elevated."

It would be interesting if the writer would state the observations upon which this statement is based. The eye is hardly accurate or quick enough to be reliable, and, in my own work, I have found that mathematical calculations based upon assumptions of behaviors of centers of gravity and wheel arrangements are the quintessence of unreliability.

Geo. L. Fowler.

New York.

GOULD AND EBERHARDT'S APPRENTICESHIP SYSTEM

At the last convention of the National Machine Tool Builders' Association, Fred L. Eberhardt, president of the Gould and Eberhardt Company, Newark, N. J., presented a paper on the apprenticeship system in use at that plant.

He stated that applicants were obtained by applying to the superintendents of public schools and the technical schools, Municipal Bureau of Labor and by advertising in the daily papers. These advertisements appeal first to the boys themselves and secondly to the parents. In addition to the work in the shop they strongly recommend that their apprentices attend the Newark Evening Technical School and a large proportion of the boys are members of that school.

In describing the system in use Mr. Eberhardt said in part:

"At present we have about 65 apprentices, all bound and indentured according to the apprenticeship laws of New Jersey, and have none who are not bound in this manner.

"We have practically two forms of apprenticeship, one for young men about seventeen years of age, embracing what we term our regular course and covering a period of four years of 10,800 hours, and another for two years, or 5,400 hours, called our 'one-branch,' and intended for young men 21 years and older. Reckoning a year at 2,700 hours, in the case of our four-year course, we have a first period of 2,000 hours at 8 cents per hour, a second 2,000 hours at 9 cents, a third 2,000 hours at 10 cents, a fourth 2,000 hours at 11 cents and a fifth 2,800 hours at 12 cents. This makes a total of 10,800 hours.

"The total hours in each period are required to be completed before the next advance in pay is made. We require that the apprentices' parents shall pay us $1 per week during the first four periods, which amount forms the collateral for a bond which the father or guardian is required to execute. This amount is returned at the expiration of the term, if the said term is completed in a satisfactory manner. However, if for any reason the terms of the papers are violated or the young man runs away, the money paid on account is forfeited. Incidentally, I would say that the amount which we pay the young man, as stated above, is larger than what it was formerly. We made it sufficiently more for the purpose of enabling the parent to pay back the $1 per week to make good the bond. In this way, we feel, we make it more feasible for a worthy young man, so to say, to pay his own way so far as securing a bondsman is concerned, a collateral bond always having been one of our requirements.

"The regular apprenticeship course includes work at the vise, lathe and planer. In addition, milling machine and gear cutting machine experience, and also other work, is afforded to those boys who show ability to absorb.

"Our experience has taught us that there is so great a variation in capacity that wherever we see a boy who shows ability we do not hesitate to advance him, and when we find a boy who does not possess ability we strongly advise him and his parents to have him take up some other line of work. This we do within the first 4,000 hours of service. It does not always take 4,000 hours to determine this, but there are times when, before taking summary dismissal measures, we try out a boy at more than one branch, or place him with different foremen, so that, in the final disposition of the case, neither the parent nor the boy can say that he was not given a fair trial. For all these efforts expended on the boy up to this time, should he prove deficient and be dismissed, we require that whatever money has been paid on account of the bond be forfeited. This is, in a measure, partly to compensate us for the time spent, work spoiled, etc., in giving the boy a chance to demonstrate, in our opinion or judgment, whether or not he is suited for the trade. The necessity for this measure does not occur often, but we feel that it is absolutely necessary to have some such method of procedure.

"Our second form of apprenticeship, called our one-branch, is for young men who, having attained their majority, realize the necessity for learning some trade and regret not having been given the opportunity in earlier years. This apprenticeship, as stated, is for two years, or 5,400 hours, divided into periods of 2,700 hours each, the first at 12 cents per hour and the second at 14 cents per hour. We require the young men themselves to pay us $1 per week, the same as before explained. This is paid back at the expiration of the term when completed in a satisfactory manner. This latter amount is also subject to the same penalties as previously mentioned.

"All of our apprentices during their apprenticeship are furnished with the necessary tools required in the several branches and we pass free title to them upon the apprentice completing his term."

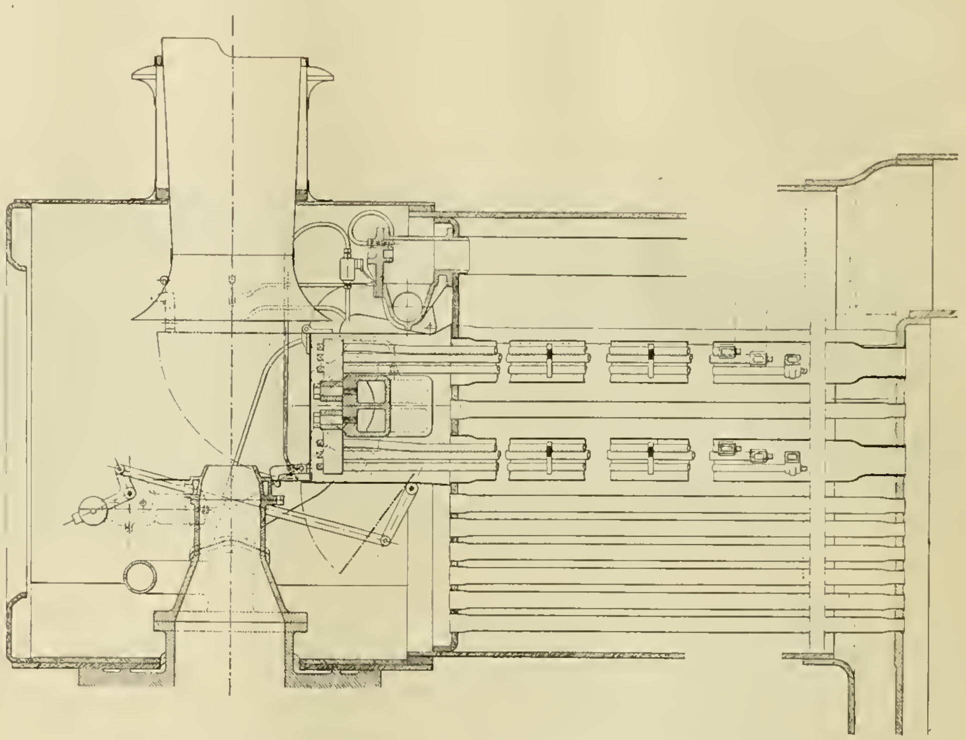
THE SWINDON FIRE TUBE SUPERHEATER.

There has been applied to a number of the Great Western (England) locomotives a new type of superheater which is the joint invention of Messrs. G. J. Churchward, locomotive superintendent; G. H. Burroughs, chief draftsman, and C. C. Champeney, draftsman. This superheater has proven to be very satisfactory in operation, and an inspection of the illustrations shown herewith indicates its simplicity of construction.

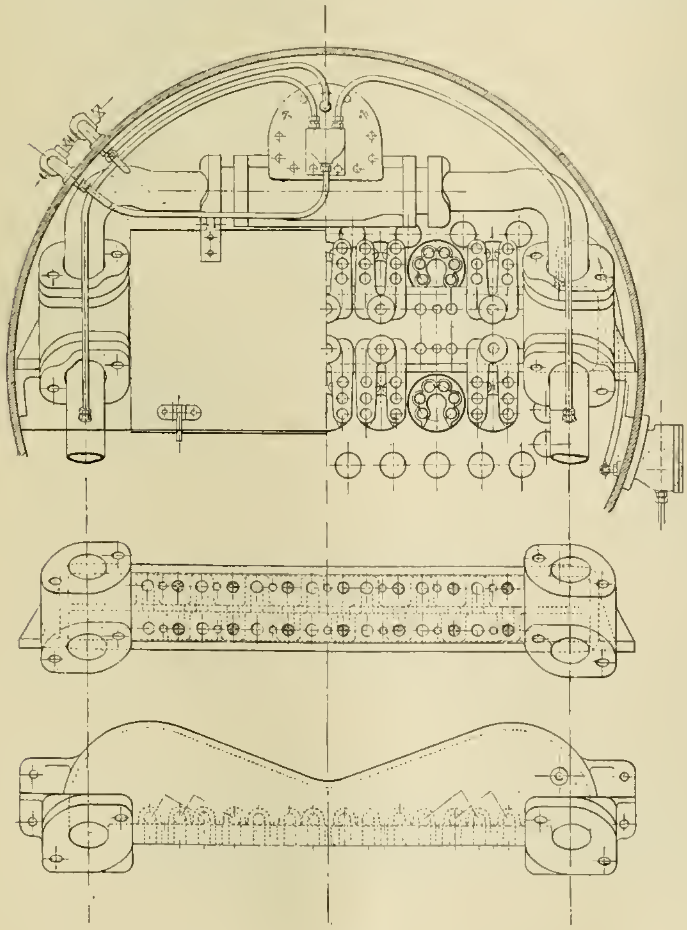
Reference to the ilustrations will show that there are three loops of one inch tubing in each superheater element. Four of these tubes being entirely straight and the two upper ones slightly bent. These six tubes are expanded into U-shaped headers, which in turn are bolted to the large main header which stretches across the smoke box. This connection is made by the use of a single stud, so that by the removal of one nut a complete element can be quickly withdrawn and if necessary a blank flange can be inserted in its place with little or no delay and while the engine is under steam. The tubes forming the elements are maintained in their relative positions by three supports throughout their length.

The two rows of fire tubes containing the elements are 5 in. outside diameter and are reduced to 3⅞ in. outside diameter at the fire box end, where they are screwed into the tube sheet. At the smoke box end they are beaded over.

A box encloses the header and the ends of the superheater elements in the front end and in the bottom of this an automatic damper operated by a small steam cylinder is provided. The front face of the box is hinged so that it can be lifted up for access to the header.



SECTIONAL ELEVATION OF SWINDON SUPERHEATER IN BOILER.



SWINDON SUPERHEATER HEADER SHOWING ARRANGEMENT OF ELEMENTS.

INTELLIGENT WORKMEN NEEDED.—The mechanical development of this or any other country depends in most part upon the intellect of the workers and the mechanical industries should avail themselves as much as possible of the educated boy, their education being paid for by the mechanical manufacturers as much as by any other citizen of the country. If we could increase the number of intelligent mechanics, we would produce more and better work and our machines would produce better and a larger quantity of work, and they would last longer in our customer's shops if they had intelligent help to handle them.—*B. M. W. Hanson before the Hartford Manufacturers' Association.*

LOSS OF WEIGHT OF STEEL CARS.—Out of 1,690 steel hopper cars weighed during the month of April the average decrease in cars which had been weighed within one year, was 702 lbs.; on 478 cars weighed within two years, 1,052 lbs.; on 132 cars weighed within three years, 1,220 lbs.; 92 cars, four years, 1,242 lbs.; 75 cars, five years and over, 1,459 lbs. In May, 671 lbs. on one-year cars; 1,004 lbs. on two-year cars; 1,224 lbs. on three-year cars; 1,571 lbs. on four year cars; 1,705 lbs. on five-year and over. Steel gondolas had not decreased quite so much; 204 cars weighed within one year, 523 lbs.; 152 within two years, 592 lbs.; three years, 878 lbs.; four years, 830 lbs.; five years, 959 lbs.—*J. R. Kearney before the Association of Transportation and Car Accounting Officers.*

BALTIMORE & OHIO SHOPS.—The Mt. Clare shops at Baltimore will be improved and enlarged. A new building is to be erected adjoining the present plant, and the foundry and erecting shops will be improved and new machinery installed.

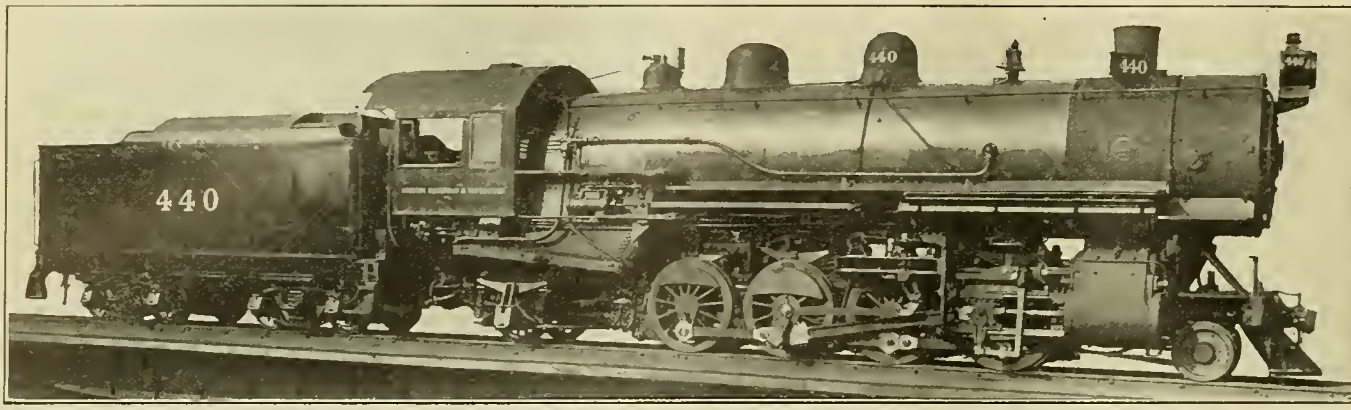
Powerful Lignite Burner of the Mikado Type.

OREGON RAILROAD AND NAVIGATION CO.

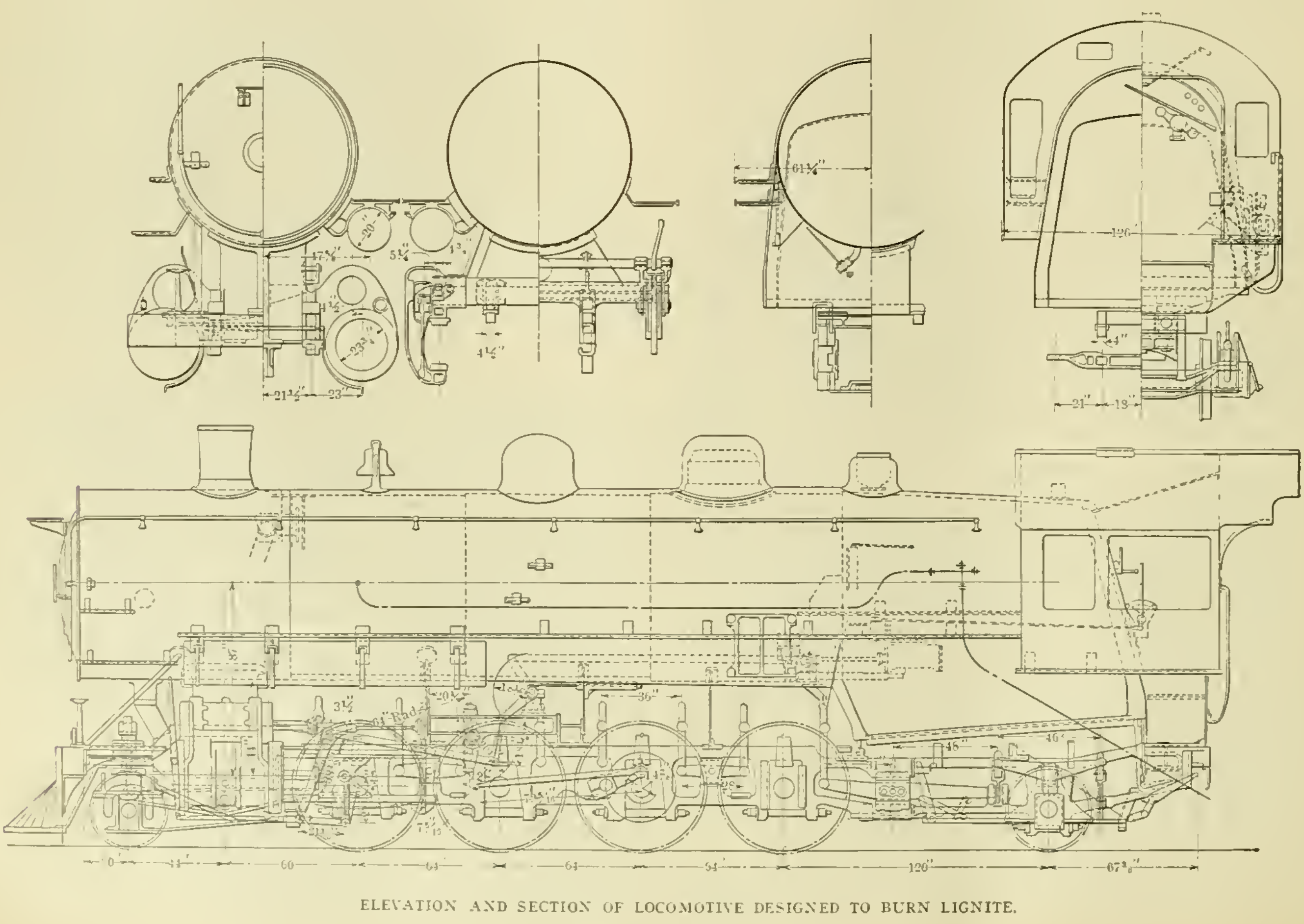
In the Northwest the many extensive deposits of lignite form an unusually cheap grade of fuel and the railroads traversing that country have used it for locomotives in freight service to some extent and are endeavoring to design a satisfactory arrangement whereby it can be used in passenger service. This fuel has probably been more extensively used on the Chicago, Burlington & Quincy Railway than on any other and on page 161 of the May, 1908, issue of this journal an illustrated article appeared discussing the development of a satisfactory design of locomotive to burn this fuel on that railroad. Other companies have from time to time purchased locomotives designed to burn lignite and the last of these is the engine shown in the accompanying illustration, which has just been delivered by the Baldwin Locomotive Works to the Oregon Railroad and Navigation Co.

This company as one of the Associated Lines adheres closely to the standards used by the other Harriman lines, but in this locomotive several changes have been incorporated, the most noticeable being the use of a radial stay boiler in place of the crown bar type. Walschaert valve gear is also used in place of the Stephenson, the design being such that although the combination lever is outside of the guides and the piston valve is inside of the cylinders, no rocker arm is employed.

In point of total weight this engine is the largest of any of



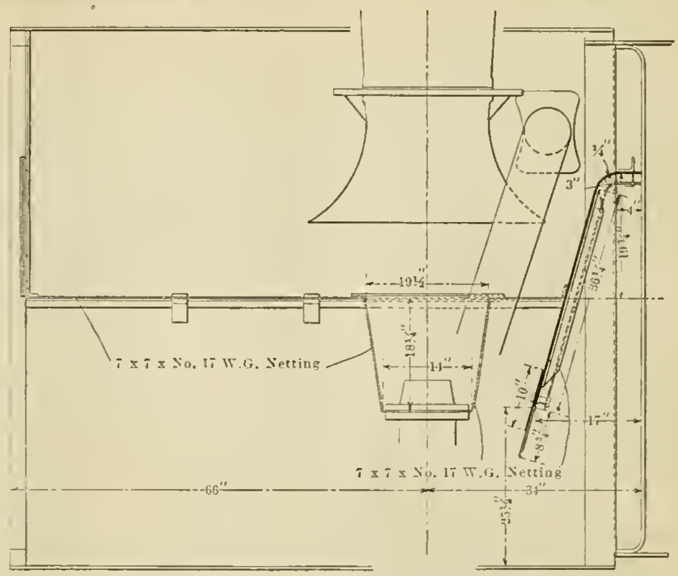
LIGNITE BURNING LOCOMOTIVE FOR THE OREGON RAILROAD AND NAVIGATION COMPANY.



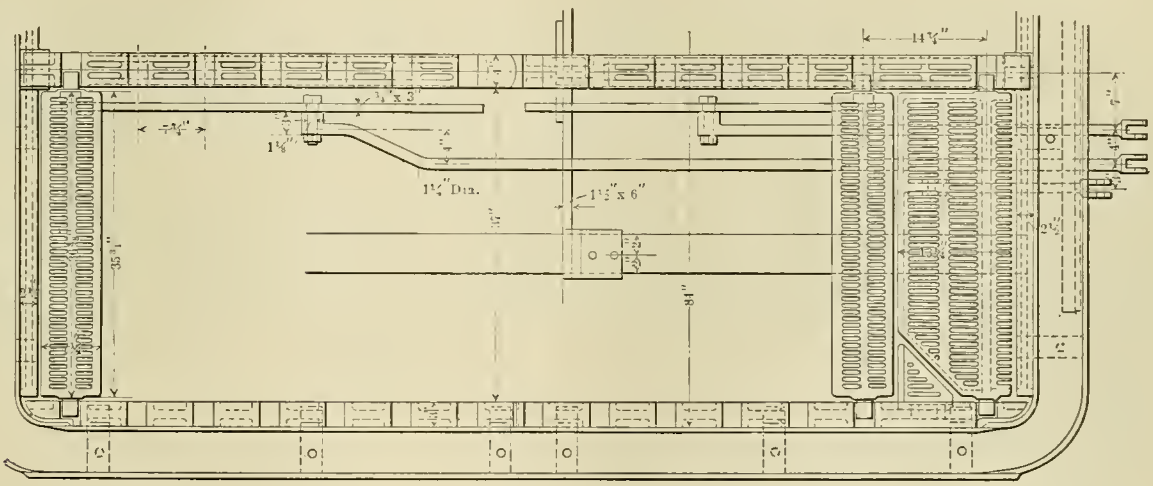
ELEVATION AND SECTION OF LOCOMOTIVE DESIGNED TO BURN LIGNITE.

this type on our records, although it is exceeded in weight on drivers by the Virginian engine* and the Northern Pacific locomotive† and in theoretical tractive effort it is exceeded by both of these as well as by the locomotives built at the Milwaukee shops of the Chicago, Milwaukee & St. Paul R. R.‡ The ratio of weight on drivers to total weight in this case is 77½ per cent., while on the Northern Pacific locomotive it is 78½ per cent.; on the Virginian it is 82 per cent., and on the Milwaukee 77 per cent.

In point of heating surface, however, this design is far in the lead of the other three, having 5,559 sq. ft., as compared to 4,466 on the Virginian; 3,614 on the Milwaukee, and 3,437 on the Northern Pacific. The latter two engines have a large combustion chamber, which accounts to some extent for the small total heating surface. In fact, a study of the design of this locomotive shows that it would probably be over boilered if a good grade of soft coal was to be used. Assuming a steam consumption of 30 lbs. of dry steam per dynamometer horsepower hour, the full tractive effort of this locomotive, at 10 miles per hour, will be obtained with an evaporation of about 6½ lbs. of steam per sq. ft. of heating surface. At this speed the piston speed in feet per minute is 294.8. At a piston speed of 250 ft. per minute, equivalent to 8½ miles per hour, the evaporation per square foot of heating surface, under the same conditions, would be a little over 5½ lbs. of dry steam.



FRONT END ARRANGEMENT FOR BURNING LIGNITE.

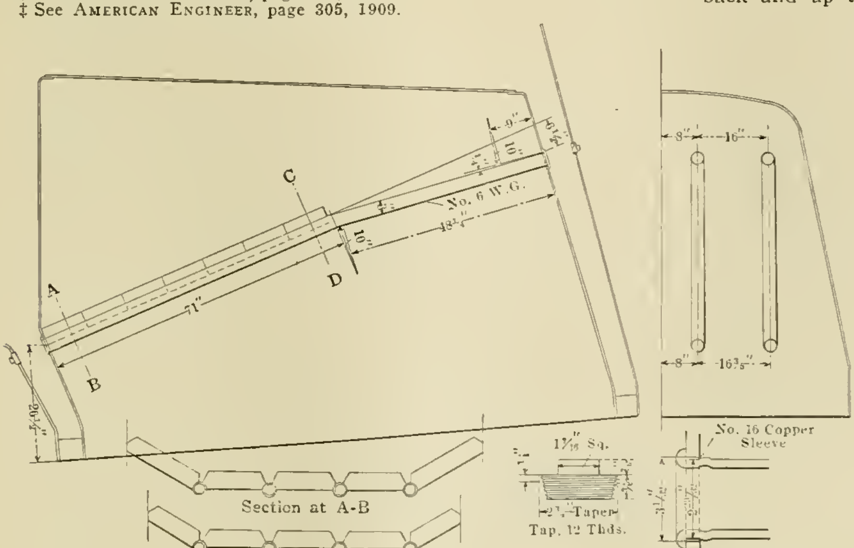


GRATES DESIGNED FOR BURNING LIGNITE.

One of the illustrations shows the grate designed for burning lignite. It will be noticed that the air openings are narrow and that the grate bars are numerous, being connected in four sections for shaking, two on either side of the center line. Two large dump grates are provided at the back of the fire box. Another illustration shows the arrangement of the brick arch supported on four 3 in. air tubes. This arch is carried well back and up to reduce the direct pull on the fire as much as possible. In the front end a large area is provided and the diaphragm plate is backed up with a netting for breaking up the sparks as they emerge from the tubes. A low nozzle is used with a bell mouthed interior extension on the stack. The grates and front end arrangement are very similar to those used on the Chicago, Burlington & Quincy illustrated in the article referred to.

As mentioned above, the boiler is of the radial stay design and it has 400 flexible stay bolts distributed on the sides, back and throat sheet. The fire door opening is formed by flanging both sheets outward and riveting them together, a form of construction which has been received with much favor on a number of roads.

In the valve gear design there is nothing unusual except the method of connecting the piston rod to the combination lever. The center of the valve chests are placed 4½ in. inside of the cylinder centers and the com-



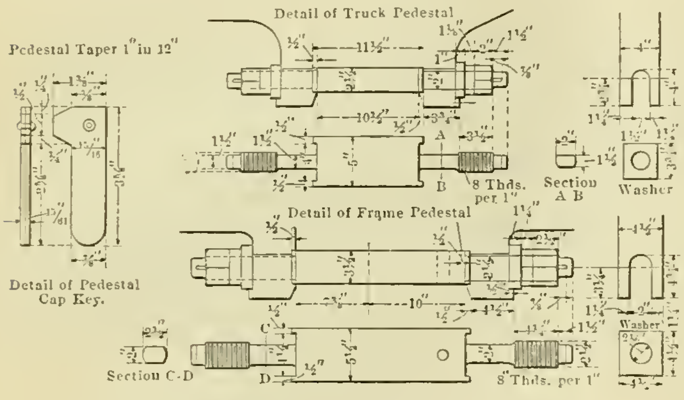
ARRANGEMENT OF ARCH TUBES AND BRICK IN THE FIREBOX.

* See AMERICAN ENGINEER, page 225, 1909.
† See AMERICAN ENGINEER, page 392, 1906.
‡ See AMERICAN ENGINEER, page 305, 1909.

bination lever outside the guides is connected to a special design of cross head sliding on the usual valve motion guide bar. This connection is made on the outside of the cross-head while the valve stem is connected to a lug on the inside, an arrangement which not only eliminates the use of the rocker arm, but simplifies the whole construction and permits the valve to be located in the best position.

Outside of these features the locomotive follows the Associated Lines practice very closely. The cylinders are cast from a 25 in. pattern and are bushed down to 23¾ in. in diameter. The piston valves are 12 in. in diameter and are set with a lead of ¼ in. Ragonette or Baldwin power reversing gear has been applied in place of the reverse lever.

The frames have separate rear sections and double front rails, the main and rear sections being of cast steel, while the



COLLINS TYPE OF PEDESTAL BINDER.

front rails are of forged iron. The pedestal binders shown in one of the illustrations are designed according to the Collins pattern. This binder fits into slots in the lower end of the pedestals and is held in place by washers which rest on lips formed on the pedestal jaws. These washers are secured in place by double nuts with cotters. This arrangement permits a wedge adjustment placed on the frame center line to be employed.

The equalization system of the locomotive is divided between the second and third pair of drivers. The front truck is of the usual center bearing type, while the rear truck has outside journals and jointed spring hangers of the same general design, illustrated on page 358 of the September issue of this journal in connection with a description of the Carolina, Clinchfield & Ohio Railway locomotives. All of the driving tires of this engine are flanged.

The general dimensions, weights and ratios are given in the following table:

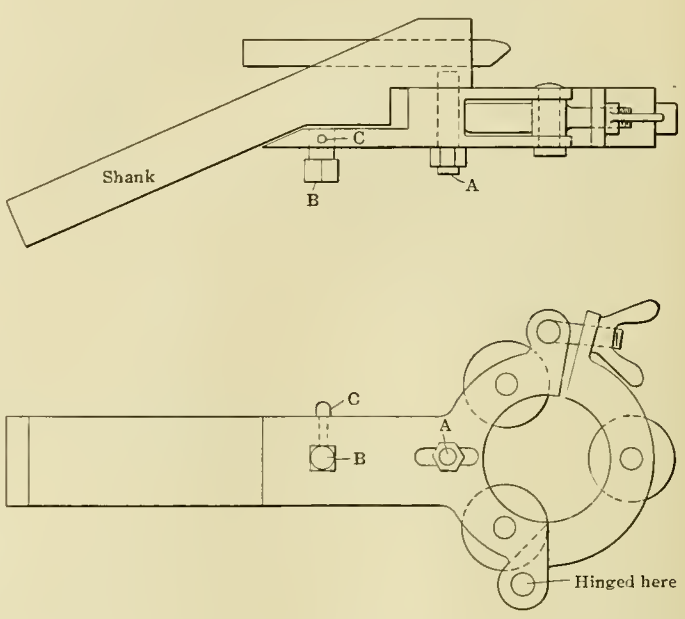
GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Lignite
Tractive effort	45,300 lbs.
Weight in working order	263,100 lbs.
Weight on drivers	204,450 lbs.
Weight on leading truck	24,100 lbs.
Weight on trailing truck	34,550 lbs.
Weight of engine and tender in working order	425,000 lbs.
Wheel base, driving	16 ft.
Wheel base, total	34 ft. 8 in.
Wheel base, engine and tender	64 ft. 7 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.50
Total weight ÷ tractive effort	5.80
Tractive effort × diam. drivers ÷ heating surface	465.00
Total heating surface ÷ grate area	79.30
Firebox heating surface ÷ total heating surface, per cent	4.80
Weight on drivers ÷ total heating surface	36.70
Total weight ÷ total heating surface	47.30
Volume both cylinders, cu. ft	15.40
Total heating surface ÷ vol. cylinders	360.00
Grate area ÷ vol. cylinders	4.53
CYLINDERS.	
Kind	Simple
Diameter and stroke	23¾ x 30 in.
VALVES.	
Kind	Piston
Diameter	12 in.
Lead	¼ in.
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	9 x 12 in.
Engine truck wheels, diameter	30½ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	36 in.
Trailing truck, journals	8 x 14 in.
BOILER.	
Style	Straight
Working presssure	180 lbs.
Outside diameter of first ring	82 in.
Firebox, length and width	120 x 84 in.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	495—2 in.
Tubes, length	20 ft. 6 in.
Heating surface, tubes	5,292 sq. ft.
Heating surface, firebox	267 sq. ft.
Heating surface, total	5,559 sq. ft.
Grate area	70 sq. ft.
TENDER.	
Tank	Waterbottom
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,000 gals.
Coal capacity	10 tons

VALVE STEM TURNING AND ROLLING TOOL.

A tool which permits the turning and rolling of a valve stem at the same time has been designed by V. T. Kropidlowski and employed with entire satisfaction in one of the Western shops.

Reference to the illustration will clearly show the arrangement. The shank carries a cutting tool which is adjustable and also a set of rollers in a hinged frame. This frame is carried by a stud on the shank, the slotted opening allowing for adjustment to suit the setting of the cutter. There is also a set screw "B" to further bind the setting of the frame after the nut on the stud "A" is tightened. This set screw is provided with a locking screw "C."

After the operator has placed the valve yoke and stem in the centers of his lathe, the thumb nut is unscrewed enough so as to swing out the roller clamp and allow the forward half of the frame to swing down. The shank of the tool is then put into the lathe tool post, the cutting tool adjusted and a cut taken, advancing the cut until the rollers will commence to bear on the valve stem. The frame is then closed, the thumb screw tightened. The nut on stud "A," set screws "B" and



TOOL FOR TURNING AND ROLLING VALVE STEMS.

"C" are then tightened in order. The operator is then ready to continue and complete the cut to the end, when the valve stem will be finished, rolled and all.

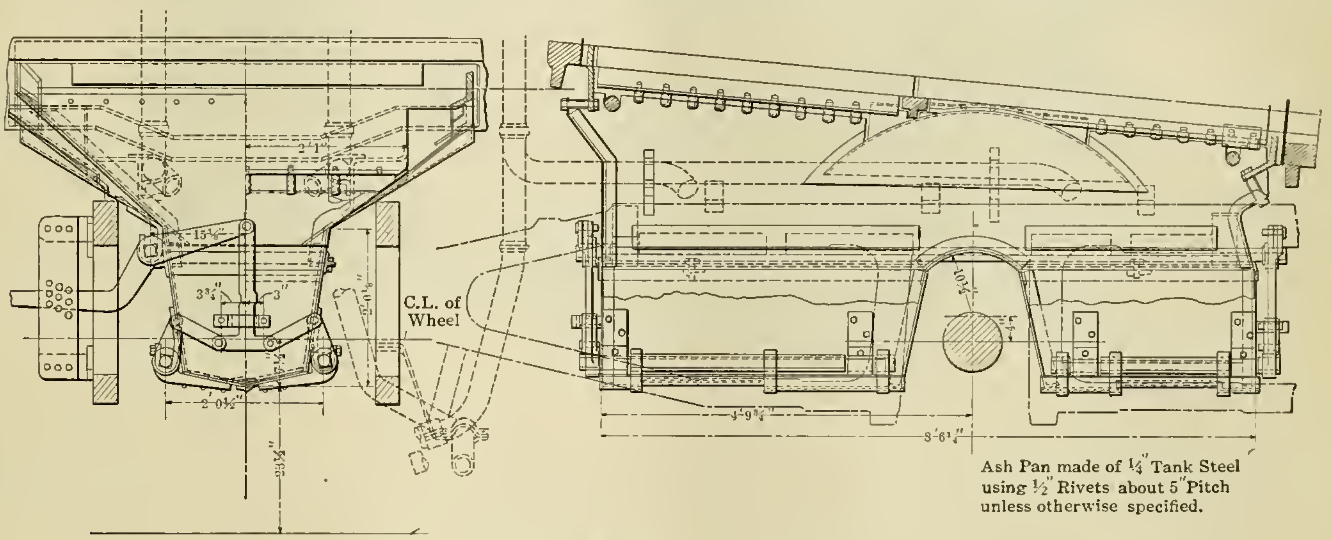
On newly forged valve stems it is better to first take a roughing cut before finishing. In taking the rough cut the same tool can be used, only leaving the roller frame open, also the same cutting tool by making it of proper shape. The time in finishing a valve stem with this tool is cut in half, and the finish on the stem is entirely satisfactory.

The rollers are 1¾ in. diameter, ½ in. face and revolve on ½ in. axles; hinge pins, set screw "B" and stud "A" are ½ in. diameter and set screw "C" ¼ in. The tool shank is 1 x 1⅝ in. and the cutting tool is ½ in. square high speed steel; other details proportionate.

SELF-CLEARING ASH PAN.

Pennsylvania Railroad.

In order to comply with the requirements of the Federal law in regard to locomotive ash pans, the Pennsylvania Railroad Company considered quite a number of different designs. After experimenting with several of the most feasible, the design shown in the accompanying illustration was adopted for use on the Pennsylvania System and previous to January 1, 1910, when the law became effective, all of the locomotives owned or operated by the Pennsylvania Railroad Company were equipped with ash pans meeting the requirements of the law, a large majority of them being fitted with this style of pan.



SELF-CLEARING ASH PAN USED ON THE PENNSYLVANIA RAILROAD.

As far as the pan proper is concerned there is nothing particularly novel about it. It has a large capacity and is very substantially built, flanged pieces replacing straight sheets and angle irons to a large extent. A liberal air opening is provided around the top.

It is in the arrangement of the doors that the principal point of interest lies. The whole bottom of the pan is formed by double doors hinged at the sides and overlapping each other in the center, so that any slight variation or warping will not leave an opening between them when they close. Near the bottom of the pan itself, on each side, are supported in suitable brackets long shafts which are square except where they pass through the supporting brackets. To the door plates are riveted heavy hinged pieces that have square holes through which the shafts pass. On the ends of the square shafts are arms which connect through links to the extensions of inverted T pieces, as is shown in the illustration. On the vertical arm an off-set is made, which, when it comes in contact with the guide, affects the relative position of the two doors, so that there will be no interference between them when being closed or opened.

On one side of the pan and above the hinged shafts is a bearing shaft from which extended arms engage the upper end of the T piece just mentioned. A suitable lever and lock for this shaft completes the operating details.

Some of the advantages which service operation of this pan has shown are as follows: The use of a toggle for closing the doors insures a tight fit without any straining or bending of the operating levers. In case either door is stuck the entire force is applied automatically to this door. There is no danger of the doors fouling each other during the process of closing and opening and it is also found that no special instructions are needed covering the method of operating the pan.

After nearly two years operation this type of pan has been found to be entirely satisfactory and is being applied to new locomotives now on order. The operating rigging is patented.

TRAIN RESISTANCE FORMULA.

In a communication to the *Engineer* (London), Lawford H. Fry, in discussing the paper on "Train Resistance," recently presented by Prof. Schmidt before the Master Mechanics' Association,* presents the following formula:

$$r = 1.5 + \frac{106 + 2V}{W + 1} + .001V^2$$

r = resistance of car in lbs. per ton (2,000 lbs.).
W = weight of car in tons (2,000 lbs.).
V = train speed in miles per hour.

which he has derived from Professor Schmidt's data, and states that it expresses the results of the experiments with the same degree of accuracy as the formula given by Professor Schmidt and has the advantage of expressing the effect of both weight and speed in the same formula.

A FEW DON'TS FOR ADVERTISERS.

Don't tell all in your advertisements—leave something for the catalogue.

Don't use small type; make reading easy.

Don't be too technical in expression; use terms easily comprehended by the average reader.

Don't make invidious comparisons.

Don't use cuts of unsuitable shapes and sizes because you happen to have them, thereby sacrificing balance and fitness of the advertisement.

Don't expect the compositor to arrange your copy forcibly; you must specify type line by line and furnish skeleton layout.

Don't permit advertisements to run without your final approval.

Don't sacrifice dignity to misapply humor in copy.

Don't crowd type matter; be generous in allowance of white space.—*J. C. McQuiston, manager of the Westinghouse Bureau of Publicity in the Trade Journal Advertiser.*

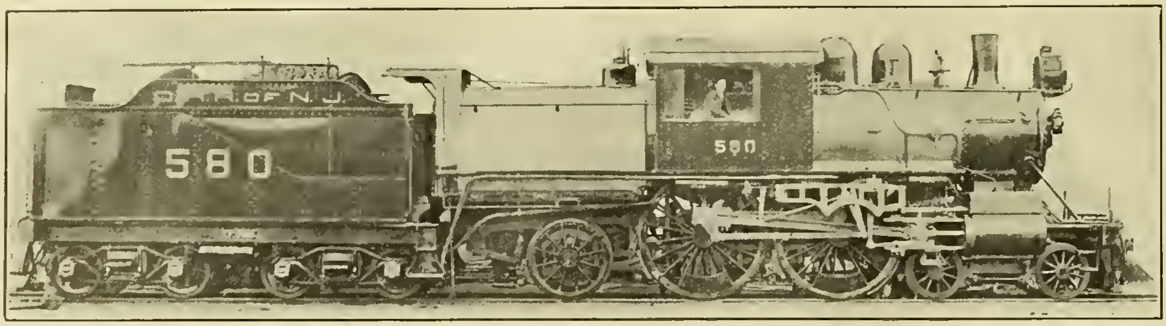
* See American Engineer, July, 1910, page 292.

A NEW RADIAL VALVE GEAR.

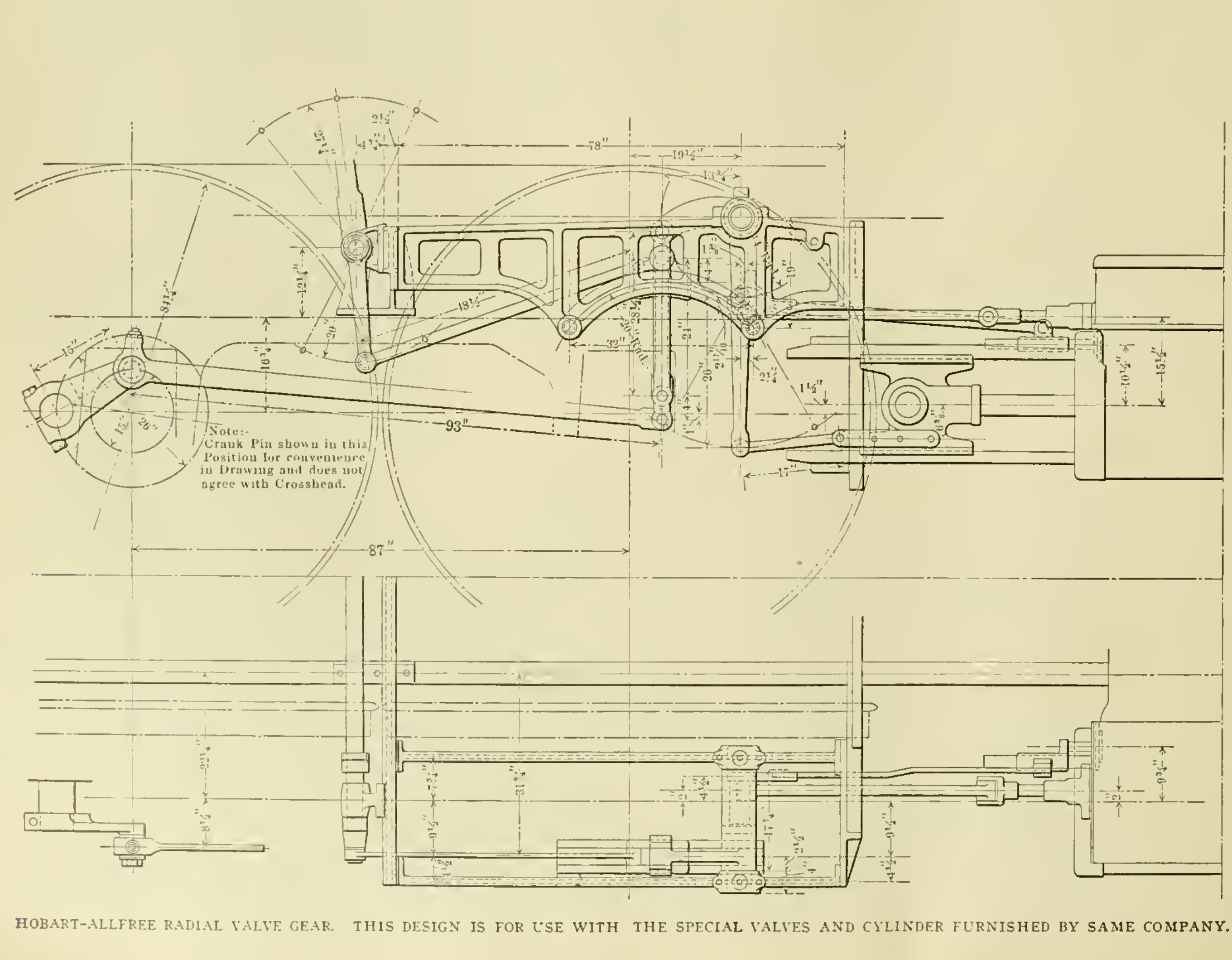
A valve gear which evidently has features of advantage over the present design in connection with maintenance is being applied to a number of locomotives throughout the country by its designers and manufacturers, the Hobart-Allfree Company of Chicago.

This gear combines with some original features the basic principles of both the Marshall and Walschaert design. The combination, however, has been worked out with such nicety that the result has been to eliminate the inaccuracies of both arrangements. Furthermore, it is so constructed that no motion is transmitted through a sliding connection. The reversing and adjustment of point of cut-off is effected by the movement of the block over a stationary arc instead of the bell crank usually employed with the Marshall gear, this being but one instance of how the usual arrangement is simplified with an improvement in mechanical design.

Reference to the illustration will show the gear as designed for use with the special cylinders and valves manufactured by this company, where a second valve and rod is required. Eliminating that feature, however, the gear is suitable for use with the ordinary piston or slide valve. The motion from the return crank is carried forward through the eccentric rod to a vertical transmission bar that is hung from one arm of the rocker. This transmission bar is also connected to the radius bar from a block which slides on the quadrant above. The position of the radius block on the quadrant is controlled directly from the reverse lever in the cab. When this block is in the center directly behind the transmission bar the motion of the rocker is practically nil. When, however, it is swung to one side the arc described by the lower end of the radius bar is inclined and the transmission bar has a vertical motion, depending upon the angularity with the horizontal of the path of the lower end of the radius bar. This arrangement being the same as is customarily used with the Marshall gear. The other arm of the rocker connects to the top of the combination lever of the regular Walschaert gear, to which the valve rod is connected in



LOCOMOTIVE EQUIPPED WITH THE HOBART-ALLFREE VALVE GEAR.



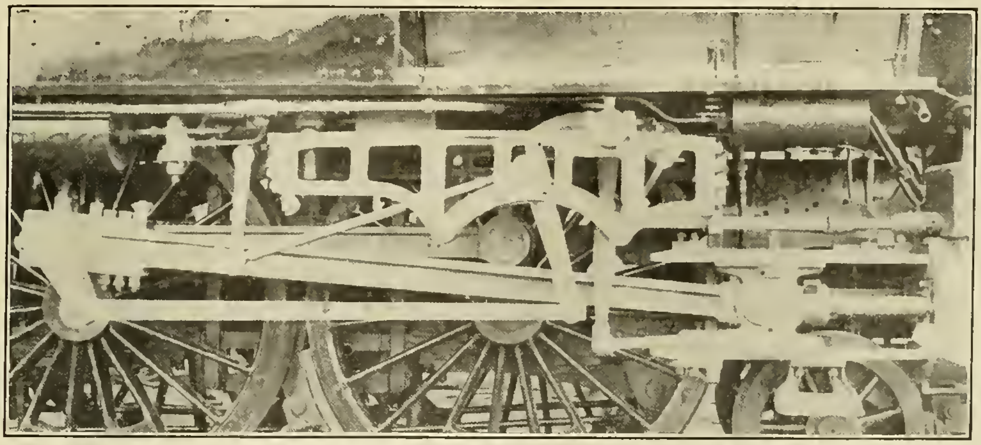
HOBART-ALLFREE RADIAL VALVE GEAR. THIS DESIGN IS FOR USE WITH THE SPECIAL VALVES AND CYLINDER FURNISHED BY SAME COMPANY.

the usual manner. The two arms of the rocker are at the proper angle to equalize the port opening and the ratios of the various parts of the gear are so adjusted as to give an unusually long cut-off in full gear.

This gear complete is carried in a frame secured outside of the driving wheel and supported by cross bars resting on the frame in the same manner as is often used with the Walschaert gear. The gear complete has about the same total weight as a well designed Walschaert gear.

The design of valves and cylinders employed by this company incorporate a separate compression valve, which is introduced through a section of the wall between the cylinder port and the exhaust passage being located beneath and to one side of the main valve. In operation this valve opens simultaneously with the main valve for release, but does not close until some time after the main valve has passed the point of compression. This construction and arrangement was very fully illustrated and described on page 334 of the September, 1906, issue of this journal. At that time the compression valve was operated internally by a connection to the main valve and experience with that arrangement has shown it advisable to operate it through an outside connection and the arrangement now used is to operate it by a connection to the combination lever above that of the main valve rod. This point is so chosen as to give the compression valve the same movement that it previously had, *i. e.,* such that it does not affect the steam distribution at any point, except that of compression, which it very materially delays, allowing a free exhaust almost to the end of the stroke and thus permitting a greatly reduced clearance area in the cylinders. In the illustration this connection with the combination lever took the form of an eccentric and strap. That construction, however, is not usually followed.

The service with locomotives fitted with this gear combined with the special valves and cylinders mentioned, is reported as having been most satisfactory, both as to steam consumption and quickness and power in starting.



GENERAL VIEW OF THE HOBART-ALLFREE VALVE GEAR.

POOLING LOCOMOTIVES.*

Improved engine house facilities, more system and better organization are favorable to the pooling of locomotives, and this practice has become more general for freight engines in the United States. As recently as in 1905 the reports on pooling presented at the International Railway Congress indicated that pooling was not used on the majority of railways in the United States under normal conditions of traffic. The large increase in traffic in proportion to the number of locomotives in 1906 and subsequent years has compelled most of the roads to resort to the pooling of freight engines and the double-crewing of passenger engines, and these methods are now well established on the majority of American railways. By improved methods the operations of cooling down, washing, and filling with hot water may be performed in less than two hours without injury to firebox and tubes, and this alone has contributed in a large meassure to the success of pooling. The reduction in boiler pressure from 225 lb. to 160 and 180 lb. has also reduced the number of boiler failures and permitted the more continuous use of locomotives which results from the pooling system.

The amount of work which the engineers and firemen do at the engine houses is now so small that it is almost confined to lubrication of machinery and inspection of tools and supplies on engines, and no dependence is placed on them for repair work. The engineer is required to report any defects or needed repairs which he observes while running the locomotive or by casual inspection on the outside. The machinery underneath is inspected by men regularly employed for that purpose, and inspection pits in the tracks approaching the engine house are now regarded as an essential of a modern locomotive terminal. With the changes in practice above indicated, the pooling of freight engines is rendered more successful and satisfactory and its effect on the cost of locomotive repairs is not so pronounced as formerly.

On some railways where shop facilities are limited, locomotives are required to make a large mileage before they go in for general repairs. The principal items which send engines frequently to the shop are worn tires, defective tubes, and, perhaps, worn driving boxes. At some engine houses all these repairs are made, the worn tires being replaced by new ones or by others which have been turned at the shop. In this way such machinery as rods, crossheads, guides and link motion, is kept in service, so that passenger locomotives make as high as 127,000 miles, and freight locomotives, 100,000 miles between general repairs, one passenger locomotive making 256,000 miles between shoppings. Passenger locomotives average 120,000 miles and freight locomotives, 95,000 miles.

On the Chicago, Burlington & Quincy for the last six months of 1909, pooled freight engines made on one division as high as 4,167 miles per month and 110 engines on three divisions averaged 3,777 miles per month. On other roads passenger engines double-crewed make an average of 6,500 to 7,500 miles per month, one road reporting for engines in express service 418 miles per day and 12,780 miles per month.

* From a paper by William Forsyth before the joint meeting of the A. S. M. E and I. M. E. at Birmingham, England.

Ability Not Age the Gauge.—A man's age is only a factor when it improves his ability, and if a young man has the same ability as an old man, that is, he has reached a high point of efficiency at a younger age than other men, it is his good fortune and he should not be deprived of this advantage because of his age.—*B. M. W. Hanson before the Hartford Manufacturers' Association.*

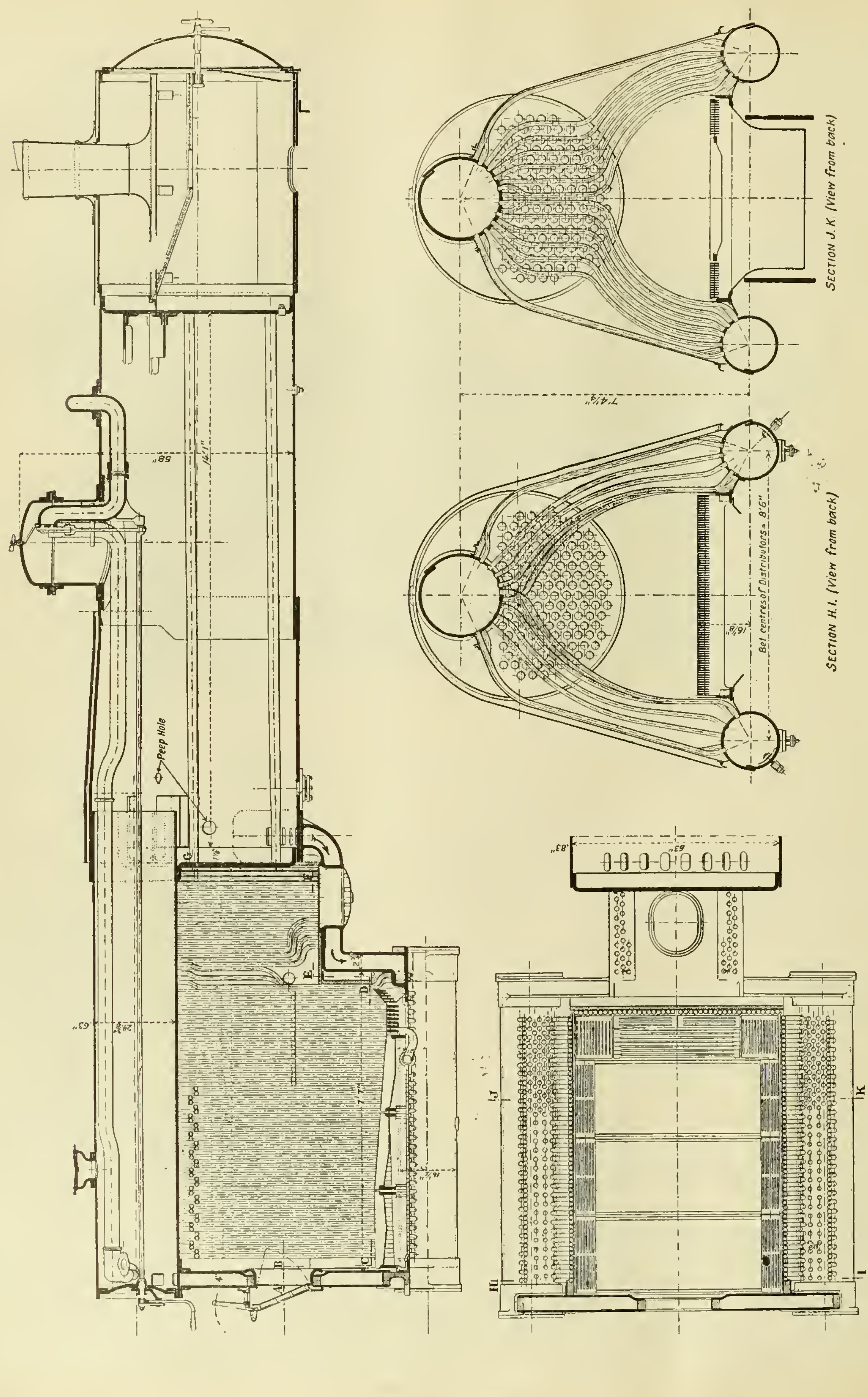


FIG. 2.—WATERTUBE FIREBOX IN SUCCESSFUL USE ON THE NORTHERN RAILWAY OF FRANCE. THIS DESIGN IS BASED ON EXPERIENCE WITH THE ONE SHOWN BELOW.

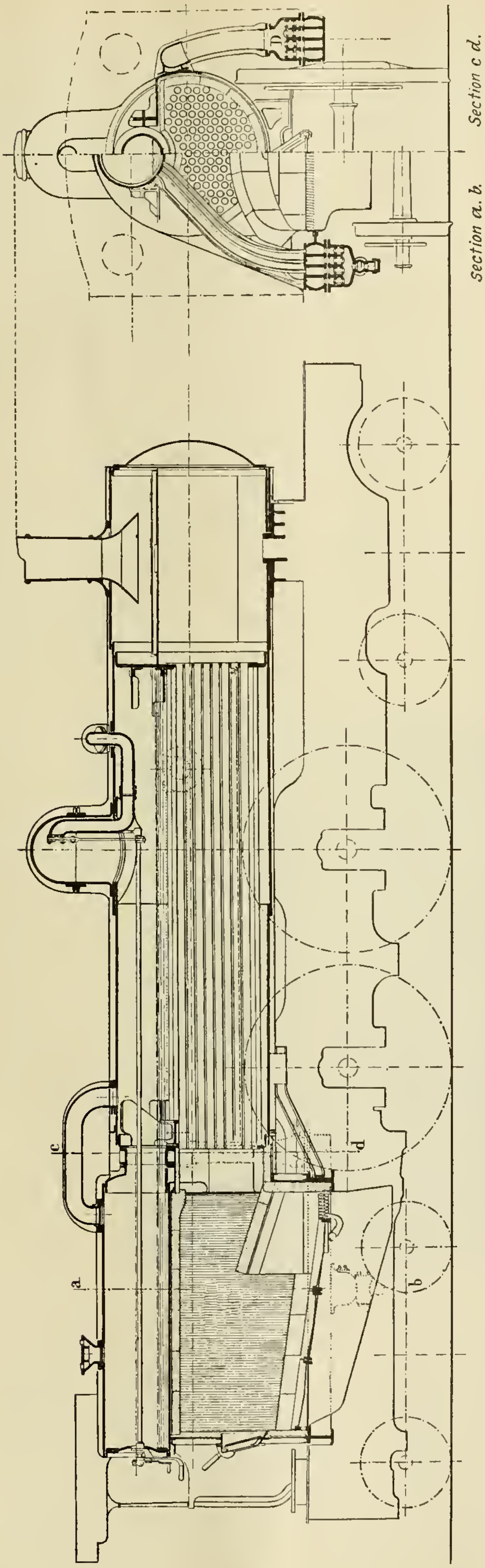


FIG. 1.—TYPE OF WATERTUBE FIREBOX FIRST USED ON THE NORTHERN RAILWAY OF FRANCE.

LOCOMOTIVE WITH WATER TUBE FIRE BOX.

NORTHERN RAILWAY OF FRANCE.

There is on exhibition in the French section of the Brussels Exposition a passenger locomotive with a very interesting application of water tube fire box. This locomotive is the culmination of about three years' experience with a water tube fire box on the Northern Railway of France. The engine built in 1907 is shown in Fig. 1 and was operated 67,000 kilometers (42,000 miles) before being replaced with the design shown in Fig. 2.

In the latter example, which was designed by the director of the Creusote Steel Works under the general direction of M. du Bousquet, the principal causes of failure in the first arrangement have been eliminated. These troubles were due largely to the use of the brick walls and bridge at the front end of the fire box, which were rapidly destroyed in spite of every preventive device introduced. All of this brick work has been eliminated in the second model and a combustion chamber has been introduced in its place for the proper protection of the fire box tube sheet, which had suffered from the action of the hot gases to an extent which made it impossible to keep the tubes tight. Reference to the section J-W in the illustration will show that the forward row of tubes forming the side legs of the fire box are bent inwards at a sharp angle and then carried up vertically to the steam drum. These act as a screen for the combustion chamber, break up, and mix the gasses passing through them and incidentally absorb a large amount of heat. In the first model a heavy steel plate was used for the tube sheet, and it was found that its rigidity in connection with the use of ribbed tubes was responsible for much of the leakage. Therefore, in the later design the tube sheet is of copper and the Servé tubes are deprived of their ribs for a length of about 16 in. and are drawn down from 2¾ to 2¼ in. diameter on that length.

In the first design there were no water legs at the front or back of the fire box, but it will be noticed that they have been provided in the later arrangement. In the first design also the lower drums were steel castings in two sections, which were bolted together. These have now been replaced by riveted steel drums into which the tubes are expanded the same as in marine practice.

Another alteration in the design will be seen in connection with the large pipe connection between the boiler shell and the front of the side drums, which was carried at a point above the center of the barrel. In practice it was found that when the fire was kindled a hot water current was rapidly set up through the water tubes, the upper part of the boiler barrel and these large side pipes, whereas the lower part of the boiler barrel unaffected by this circulation remained for a long time at a lower temperature, with a consequent unequal expansion in the barrel that caused trouble. This difficulty has been remedied by taking the water from the bottom of the boiler barrel through the regular water leg, formed in this case by steel castings and connected to the bottom headers of the fire box. The connection of these cast steel passages forms the bottom of the combustion chamber, and the sides are formed by small water tubes closed tight together, and forming a gas tight wall.

The arrangement and shape of the tubes is well shown in the illustration. Those which are exposed to the more direct action of the flames are 5 *mm.* (.2 inch) thick and the others 2½ *mm.* (.1 inch) thick.

Service with this later design has been very satisfactory during the 33,000 kilometers (22,000 miles) it operated before going to the exhibition. No flue leakage occurred and there are practically no deposit of scale in the water tubes. Tests showed that while the temperature in the fire box sometimes runs up to 2,372 degs. F., the temperature at the entrance to the flues was only about 1,562 degs. F. and the smoke box temperature 672 degs. F.

This water tube fire box boiler has been applied to the standard compound locomotive which as ordinarily used is of the

4-4-2 type. It was found, however, that the weight of the new firebox was such as to require the use of the 4-4-4 type. This engine, with a load of 270 tons behind the tender, is easily able to maintain a speed of 64 to 65 miles per hour on a steady rise of ½ of 1 per cent.

The general dimensions of this boiler as given in the *Railway Engineer,* to whom we are indebted for the information and illustrations, are as follows:

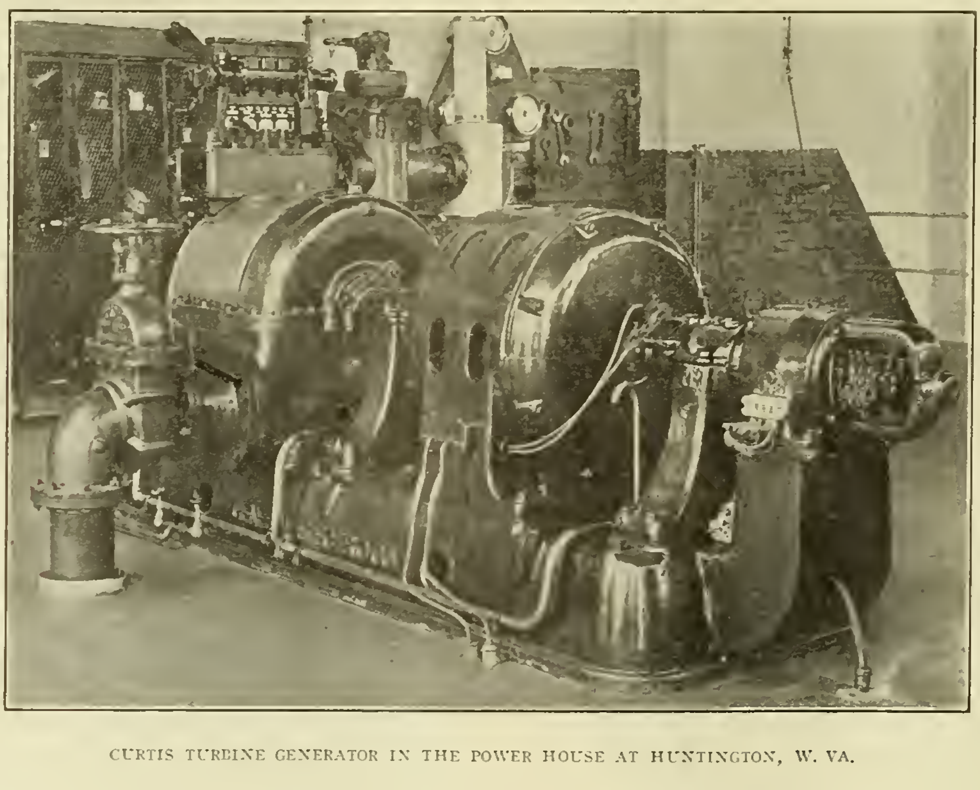
Pressure	256 lbs.
Grate area	38 sq. ft.
Heating surface, fire box	1033 sq. ft.
Heating surface, tubes	2375 sq. ft.
Heating surface, total	3408 sq. ft.
Water tubes, number and diameter	290—1.38 in.
Water tubes, number and diameter	168—1.38 in.
Water tubes, combustion chamber, number and diameter	44—1.38 in.
Fire tubes, number and diameter	136—2.76 in.
Fire tubes, length	14 ft.
Cubic capacity of boiler for water	217 cu. ft.
Cubic capacity of boiler for steam	88 cu. ft.
Total weight of boiler and accessories	30 tons
Cylinders, diameter	13.4 and 22 in.
Cylinders, stroke	25.2 in.
Driving wheel, diameter	80 in.
Maximum tractive effort compound	22,600 lbs.
Total weight of locomotive in working order	170,000 lbs.

ELECTRIFICATION OF THE CHESAPEAKE & OHIO SHOPS AT HUNTINGTON, W. VA.

The greater flexibility and efficiency of electric transmission in large shops is coming to be more widely recognized and in spite of the comparatively high cost of installation into a shop already in operation, some railroads have been availing themselves of these advantages in addition to increased output of the shop and the saving in operating expenses and large amount of space which may be effected by this means.

The Chesapeake and Ohio Railroad Company has recently changed its shops, which were formerly operated from four independent stations equipped with old locomotive boilers and reciprocating engines belted to line shafting in the different shops, from line shaft to electric drive. The conditions existing before the change was made are similar to those found in a great number of railroad shops, and while the many advantages of electric drive may be apparent to the shop superintendents, it has always been a difficult matter to obtain authority for making a change of this kind.

The new plant, which was put in service March 1, 1910, is an all turbine station, the only reciprocating machinery besides the boiler feed pumps being two two-stage air compressors furnished by the Ingersoll Rand Co. and the Chicago Pneumatic Tool Co. to supply compressed air at 100 lbs. pressure for the portable drills, hammers and hoists about the various shops. The reliability, safety and high efficiency of modern steam turbines, when operating at a varying load such as that of a machine shop, led to their selection for this purpose. Three Curtis turbines and one motor generator exciter have been installed, this equipment consisting of one two-bearing over-hung non-condensing turbine with a speed of 3,600 r.p.m. connected to a 25 k.w. 125 volt D. C. exciter; one four-bearing three-unit, 100 k.w. set consisting of one non-condensing 3,600 r.p.m. turbine, one three-phase, 60 cycle, 480 volt, 100 k.w. generator and one 4 k.w., 125 volt D. C. exciter; and also one three-bearing four-stage condensing turbine with a speed of 1,800 r.p.m. connected to a 750 k.w., three-phase, 60 cycle generator. The illustration shows the 100 k.w. Curtis turbine direct connected to its generator. All of these turbines are equipped with oil pumps geared directly to the main shaft and the bearings are fitted with oil rings. The large 750 k.w. and 100 k.w. turbines are equipped with a mechanical speed controlling valve gear driven directly from the main shaft. The 750 k.w. turbine is connected to a Westinghouse-LaBlanc jet condensor whose circulating and rotary air pumps are driven by a 75 h.p. induction motor, the injection water being cooled by a natural draft cooling power, which arrangement maintains a vacuum of about 27 in. For facilitating the erecting and subsequent handling of this machinery the engine room is provided with a 7½ ton Harris hand crane extending across the entire room. There is a standard General Electric 8 panel switchboard consisting of two machine panels, two exciter panels, four 3-circuit feeder panels and one-half panel on which a voltage regulator is mounted. In addition to the switchboard, all instruments in connection with it were furnished by the General Electric Co.



CURTIS TURBINE GENERATOR IN THE POWER HOUSE AT HUNTINGTON, W. VA.

The boiler equipment consists of five 275 h.p. Sterling water tube boilers, equipped with shaking grates. No ash handling or coal conveying machinery has been installed, the ashes being shoveled from the ash pits into small cars and conveyed in this manner to the dump. Coal is delivered in railroad cars on a trestle just outside of the boiler room and dumped into coal bunkers, from where it is carried by gravity through chutes to a point within easy reach of the firemen. The smokestack, 200 feet high, is built of reinforced concrete and is provided with a Bushnell damper regulator. Condensing and boiler feed water is supplied from a small pumping station located outside of the shops, and the feed water is pumped from an open heater to the boilers by two duplex pumps, the piping being so arranged that the condensing water may be pumped directly from the hot well to the cooling tower.

Induction motors totaling about 1,000 horsepower are used throughout the machine shop, boiler shop, roundhouse, planing mill and tin and pipe shops. They range in size from 15 to 100 horsepower each, for driving the different tools in the shops. Most of the machines are belt driven and only the larger tools are equipped with individual motor drive. A sawdust and shaving exhaust system has been installed in the planing mill, driven by a 100 h.p. induction motor. The storage battery charging station for passenger coaches is equipped with a motor generating set and the dismantling shop is spanned by a 120 ton four-hook Harris electric crane equipped with four variable speed induction motors of the slip ring type.

The various buildings about the shop are heated by the exhaust steam from the two air compressors, boiler feed pumps, the 25 k.w. and 100 k.w. turbines, the condensation from the system being pumped into the boiler feed water heater. This arrangement reduces the back pressure in the exhaust header to from four to eight lbs. per square inch.

The saving in coal alone effected by the changes made in this plant is about 50 per cent., caused in part by the great economy in steam consumption of the turbines and chiefly by the elimination of the large amount of shafting and belting, which usually consumes about 50 to 60 per cent. of the total power for a shop of this kind. A saving of 66⅔ per cent. in the labor required to operate the plant has also been effected, due partly to the improved method of handling fuel and ash, and partly to the comparatively smaller number of men required to operate a turbine station. In addition to this saving in fuel and labor the capacity of the entire shop has been increased about 50 per cent During the month of April 34 locomotives were repaired, while 20 locomotives was considered an exceptionally good month's work previous to the change. The electric drive in this case not only increased the output, but also the flexibility of the entire shop was increased, so that at the present time any section of the shop can be worked independently of the other sections and sufficient power is available at all times so that workmen can work to advantage at night as well as during the regular working hours.

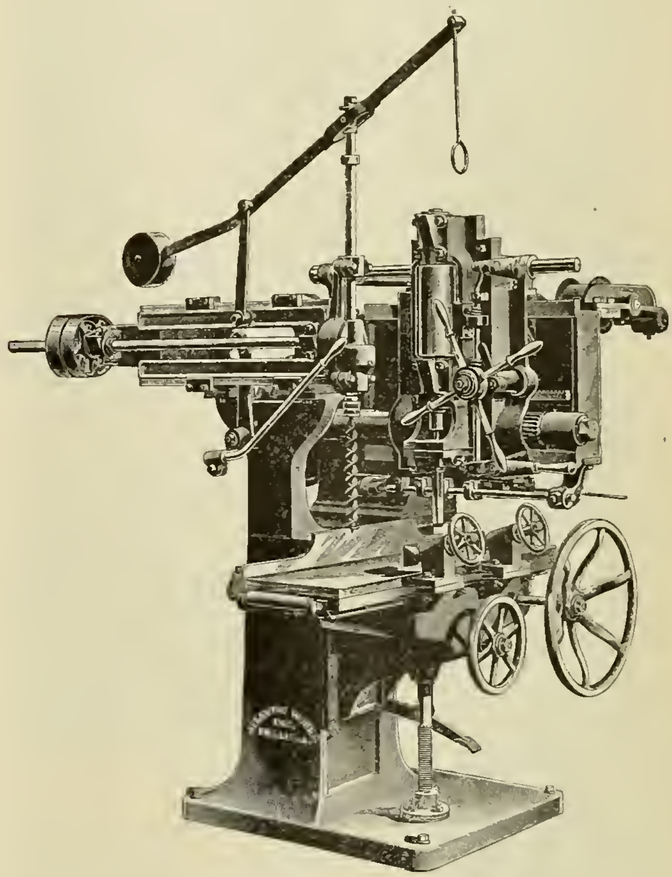
The engineering of the entire plant was done by Westinghouse, Church, Kerr & Co., of New York City.

VERTICAL HOLLOW CHISEL MORTISING MACHINE

A new mortising machine specially designed for work in car shops is shown in the accompanying illustration. It is of the vertical hollow chisel type and is provided with a boring attachment. The adjustment is such that it can make mortises very rapidly from 1 to 1½ in. in width of any length and up to 6 in. in depth if needed. The stroke of the chisel ram is regulated by a system of stops and can be increased or decreased at will, the maximum stroke being 6½ in. At this depth the automatic attachment provides for 35 strokes per minute, which is increased as the stroke is shortened. It has a very quick return. A horizontal adjustment of 3 ft. and a vertical adjustment of 14 in. is provided on the table shown and a table with a horizontal adjustment of 10 ft. with the same vertical adjustment can be fitted if desired.

The boring spindle has a vertical movement of 12 in. and a transverse movement of the same amount, both being controlled by hand levers, as is clearly shown in the illustration. It will carry augers up to 2 in. in diameter and provides a very powerful drive.

This machine, which weighs 4,000 lbs. when fitted with a 4-ft.



COMBINED HOLLOW CHISEL MORTISING AND BORING MACHINE.

table, is designated as the No. 10 by the Atlantic Works, Inc., 28th St. and Gray's Ferry Road, Philadelphia, who are the manufacturers. Long experience in designing machines of this character fits this company exceptionally well for turning out a product that is perfectly suited for the work to be performed.

The Value of R. R. Clubs.—The very fact that its rules do not bar or favor certain departments of the railroad, is positive proof value of the of the clubs. It insures papers from each department, and although papers are more thoroughly discussed by each respective department that the papers pertain to, yet the different departments are so closely allied that it is not an uncommon occurrence for several departments to take up the same discussion. This shows a broadening out of the railroad employes. Time was when each employe stayed in his own department, worked for his own department, and cared very little as to what was going on outside of his own circle, for which he was designated and paid. Never in the history of railroading has there been such an interest displayed by employes in one department, as to what is transpiring in another. Not in a jealous nature, but one of interest for the employer and at the same time, of learning, progressiveness and push. The sociability, mixed with business, now-a-days among railroad employes, has fought many a battle, and taking all things into consideration, there are to-day practically no departments on a railroad, as it were, because of this mixing, good fellowship and get together idea. I can well remember when jealousy among railroad employes was the biggest enemy that the railroad and employes had to contend with.—*J. W. Kreitter, Supt. Duluth, Missabe & Northern Ry., before Northern Ry. Club.*

EQUIPMENT AND EXTENT OF ELECTRIFIED STEAM RAILROADS AND ELECTRIC TRUNK LINES.*

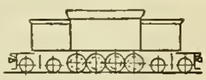
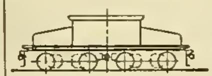
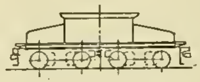
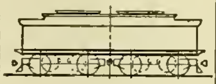
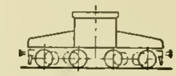
The locomotives on which data are given in the accompanying tables were built for heavy railway service. They are for passenger service and for combined passenger and freight, and include locomotives for direct current, three-phase current, and single-phase alternating current, and others adapted for operation on either single-phase alternating current or direct current.

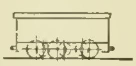
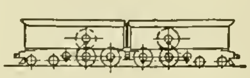
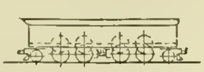
The following tables give data of the important railways on which electricity is used in heavy service. Only such figures are included as were conveniently available, and such omissions or inaccuracies as may occur do not detract materially from the forceful presentation of the extent and character of the use which is now being made of electricity in railway service. The horsepower ratings of the various motor cars and locomotives are in general the nominal ratings for a short period, usually one hour, but as these ratings have been adapted in some cases to the particular service in which the motors are to operate, they cannot be taken as a basis for an accurate comparison between the capacities of different equipments.

* From the appendices of the paper on "Electrification of Railroads," by George Westinghouse, president A. S. M. E., presented at the joint meeting with the Inst. Mech. Engrs., July, 1910.

Single-Phase Electrification on Steam Railways and in Trunk Line Service.

Road.	Miles Of line.	Miles Single track.	Line voltage.	Motor cars No.	Motor cars H.p.	Locomotives No.	Locomotives H.p.
N. Y., N. H. & H.:							
Main line	21	100	11,000	4	600	41	1,400
New Canaan Branch	8	8	11,000	2	500	2	1,600
Grand Trunk	3.5	12	3,300	..	...	6	900
Erie: Rochester Division.	34	34	11,000	6	400	..	.....
Colorado & Southern:							
Denver & Interurban	46	46	11,000	8	500	..	.....
Baltimore & Annapolis:							
Short line	25	30	6,600	12	400	..	.....
Swedish State Rys.	7	7	20,000 / 3,300	2	240	1	300
Midland Ry. of England	8.5	17	6,600	1 / 2	300 / 360	.. / ..	..... / .....
Prussian State	16.5	31	6,600	20 / 42 / 54	250 / 400 / 345	1	1,500
Lon., Brighton & S. Coast.	8.6	17.2	6,000	16	460	..	.....
Rotterdam-Haag-Scheveningen	20.5	46.5	10,000	19	360	..	.....
Spokane & Inland	129	129	6,600	28	400	6 / 6	720 / 500
Midi Ry. of France	75	..	12,000	30	500	2	1,600

					
Built for	N. Y. C. & H. R. R.	Detroit River Tunnel	B. & O. R. R.	Great Northern	Paris-Orleans
Electric system	D.C.	D.C.	D.C.	3-phase	D.C.
Service	Passenger	Frt. & Pass.	Frt. & Pass.	Frt. & Pass.	Passenger
First placed in service	July 1906	tests completed	March 1910	July 1909	1899
No. in service or on order May 1910	47	6	2	4	11
No. motors per locomotive	4	4	4	4	4
Armature diameter, inches	20	25	25	35¾	23½
Core length, including vent. opening, inches	19	11½	11½	16¼	12
Weight one motor, pounds	18,150	10,560	10,560	15,000	8,855
Weight all motors on locomotive	72,600	42,240	42,240	60,000	35,420
Weight all electrical parts	91,200	54,000	54,000	109,000	42,500
Weight all mechanical parts	138,800	146,000	130,000	121,000	67,500
Weight complete locomotive	230,000	200,000	184,000	230,000	110,000
Weight on driving wheels	141,000	200,000	184,000	230,000	110,000
Weight complete locomotive for A.C. operation	D.C.	D.C.	D.C.	230,000	D.C.
Max. guar't'd speed, miles per hr.	75	30	55	30	45
Feature limiting speed	track	armature	armature	armature	armature
Max. tractive effort	47,000	67,000	61,000	77,000	37,000
Loco. wt. in excess of 18% adhesion Max. T.E., A.C. operation	none	none	none	none	none
Designed for trailing load, tons: Freight / Passenger		900 / 600 on 2% grade	850 / 500 on 1½% grade	500 on 2.2% grade	
Balance speed on level with above load	435 / 63	Freight 20.5 / Pass. 22	Freight 26 / Pass. 30	15	300 / 32

					
Built for	New Haven	Grand Trunk St. Clair Tunnel	Pennsylvania	New Haven	New Haven
Electric system	A.C., D.C.	A.C.	D.C.	A.C., D.C.	A.C., D.C.
Service	Passenger	Frt. & Pass.	Passenger	Frt. & Pass.	Frt. & Pass.
First placed in service	July 1907	February 1908	17,000-mile test	3000-mile test	building
No. in service or on order May 1910	41	6	24	1	1
No. motors per locomotive	4	3	2	4	2
Armature diameter, inches	39½	30	56	39½	76
Core length, including vent opening, inches	18	14¾	23	13	13
Weight one motor, pounds	16,420	15,660	45,000	19,770	41,600
Weight all motors on locomotive	65,680	46,980	90,000	79,080	83,200
Weight all electrical parts	110,400	58,400	127,200	130,000	135,000
Weight all mechanical parts	94,100	73,600	204,800	130,000	125,000
Weight complete locomotive	204,500	132,000	332,000	260,000	260,000
Weight on driving wheels	162,000	132,000	207,800	180,000	180,000
Weight complete locomotive for A.C. operation	196,000	132,000	D.C.	241,000	240,000
Max. guar't'd speed, miles per hr.	about 86	30	about 80	45	45
Feature limiting speed	track	armatures	connecting rod	armatures	armatures
Max. tractive effort	19,200	43,800	69,300	40,000	40,000
Loco. wt. in excess of 18% adhesion Max. T.E., A.C. operation	88,700	none	none	18,500	17,500
Designed for trailing load, tons	250	500	550	1500 freight / 800 pass.	1500 freight / 800 pass.
Balance speed on level with above load	about 75	about 25	60	35 freight / 45 pass.	35 freight / 45 pass.

GENERAL SPECIFICATIONS OF ELECTRIC LOCOMOTIVES USED ON ELECTRIFIED STEAM RAILROADS.

Continuous-Current Electrification on Steam Railways and in Trunk Line Service.

Road.	Miles: Of line.	Miles: Single track.	Line voltage.	Motor cars: No.	Motor cars: H.p.	Locomotives: No.	Locomotives: H.p.
New York Central	33	132	650	137	400	47	2,200
Pennsylvania	20	75	650	180	400	24	4,000
West Shore	44	106	650	20	360	..	.....
Long Island	42	125	650	137	400	2	1,200
West Jersey & Seashore..	75	150	650	68	400	..	.....
Baltimore & Ohio........	3.7	7.4	600	..	...	2.5 5	1,600 1,100
Northeastern Railway ...	37	..	600	..	300	2	600
Mersey Tunnel	4.8	..	600	24	400	..	.....
Lancashire & Yorkshire..	18	60	600	..	600	..	.....
Great Western	5	..	600	..	600	..	.....
Metropolitan Railway	..	67	600	56	600	10	800

Car Equipment of Subway and Elevated Systems in American Cities.

The Direct-Current Third-Rail System at Approximately 600 Volts Is Used in All Cases.

Road.	Miles of single track.	Motor cars: No.	Motor cars: Horse-power.
Boston Elevated	19	219	320
Brooklyn Rapid Transit................	71	558, 101	300, 400
Interborough Rapid Transit (New York)	190	969, 764	250, 400
Hudson & Manhattan (New York)......	12	140	320
Chicago & Oak Park Elevated..........	19.4	65	320
Metropolitan West Side (Chicago)......	51.1	15, 210	400, 320
Northwestern Elevated (Chicago).......	25.5	20, 128	250, 320
Southside Elevated (Chicago)...........	36.5	150, 70, 150	180, 150, 110
Philadelphia Rapid Transit..............	11	100	250

Three-Phase Electrification on Steam Railways and in Trunk Line Service.

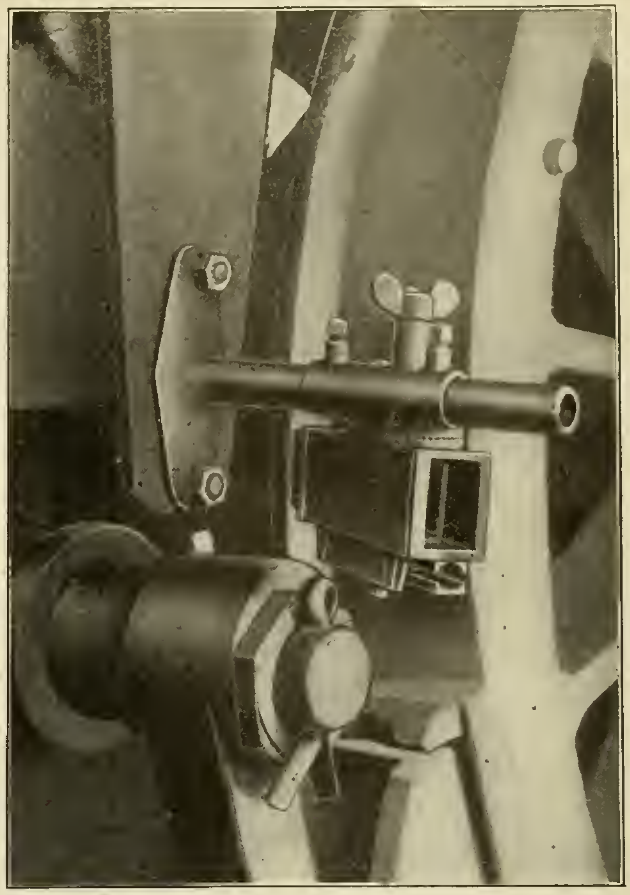
Road.	Miles: Of line.	Miles: Single track.	Line voltage.	Motor cars: No.	Motor cars: H.p.	Locomotives: No.	Locomotives: H.p.
Gt. Nor. (Cascade tunnel)	4	6	6,600	..	...	4	1,900
Italian State Railways:							
Valtelina Railway	66	..	3,000	10	400	2 7	800 1,500
Giovi Railway	12.4	37.3	3,000	..	...	20	2,000
Mt. Cenis Tunnel	4.4	..	3,000	..	...	10	2,000
Savona Ceva	..	..	3,000	..	...	10	2,000
Swiss Federal Railways: Simplon Tunnel	13.7	14.3	3,000	..	...	2 2	1,100 1,300
Garagal Santa Fe (Spain)	13.1	14.4	5,500	..	...	5	320

DRIVING WHEEL FLANGE LUBRICATOR.

On roads having numerous curves the matter of sharp flanges is one of the most important and expensive features of maintenance that have to be contended with. Recently the practice of lubricating the flange of a driving wheel has been introduced with very decided success and it has been found that a locomotive equipped with a flange lubricator will in some cases give twice the mileage before it needs to be taken in for tire turning that was previously possible. While, of course, the expense and delay in turning tires is the most important feature in this connection there is also some gain in the power of the locomotive, there is considerably less wear on the rail heads and the general machinery of the locomotive is not strained as much.

In applying a flange lubricator it is of particular importance that it shall operate and be of such form that there will be no possibility of getting any of the lubricant on the wheel tread or the head of the rail. Therefore, while oil has in certain instances been used with some success, a solid block of lubricant, as a stick of graphite, is much more satisfactory.

In the accompanying illustration is shown a wheel flange lubricator which has proved remarkably successful in practice. Its simplicity and durability are easily recognized from the photograph and it will be seen that it is provided with all necessary adjustments and so designed that it can be easily located to avoid sand pipes, brake hangers, and other parts. It is recommended by the manufacturers of this appliance, the Collins Metallic Packing Co., of Philadelphia, that it be set at an angle of 25 degs. with the axle, and while it can be located on either the front or back of the wheels, they recommend that it be on the front of the leading wheel and on the rear of the back driving wheel, and that it also be set slightly above the center line. There is a compression latch on the bottom of the device which engages the lubricating block. One setting of the block is sufficient for two or three hundred miles' service, and pulling the compression device back one notch can be done in an instant and prepares the lubricator again for an equal service. A new block can also be applied very easily. The manufacturers report



WHEEL FLANGE LUBRICATOR APPLIED TO FRONT DRIVER.

that one lubricating block will make from 2,500 to 3,000 miles on a high speed passenger and 3,500 to 4,000 on a switch engine. The heating of the tire, due to excessive braking, does not affect the efficiency of the lubricator.

ONE LOCOMOTIVE PULLS 120 LOADED CARS.

On August 23 Pennsylvania locomotive No. 1221, Class H8b * left Altoona, east bound, with 120 loaded cars, the gross tonnage of cars and lading being 8,850 tons. The train left the yard without assistance and the locomotive handled it alone to the Enola yard, a distance of 127 miles. The train on arriving consisted of 119 cars, one having been set out at Huntingdon on account of a broken brass, the gross tonnage then being reduced to 8,778 tons.

This train was operated on the following schedule:

Miles.	Station.	Time Arrived.	Time Left.	Remarks.
0	Altoona	....	7.38	
25.6	Warrior Ridge	8.45	9.09	Took water.
...	Huntingdon	9.22	9.42	Set out car.
19.4	Vineyard	10.51	11.25	Engine cut off for water.
27	Denholm	12.53	2.05	Took coal and water.
26.1	"BW" .... (2.4 miles west of Bailey)	3.28	....	Stopped for water.
4.1	"BD" .... (1.7 miles east of Bailey)	....	4.0	
15.1	West End Susquehanna Bridge.		4.47	
120.9		4.47 P.M.	7.38 A.M.	Total included time.

Running time—6 hours 29 minutes.
Average speed—19 miles per hour.

This train, because of its extreme length, was fitted with a telephone between the locomotive and the cabin car and was handled under the direction of the officials who accompanied it.

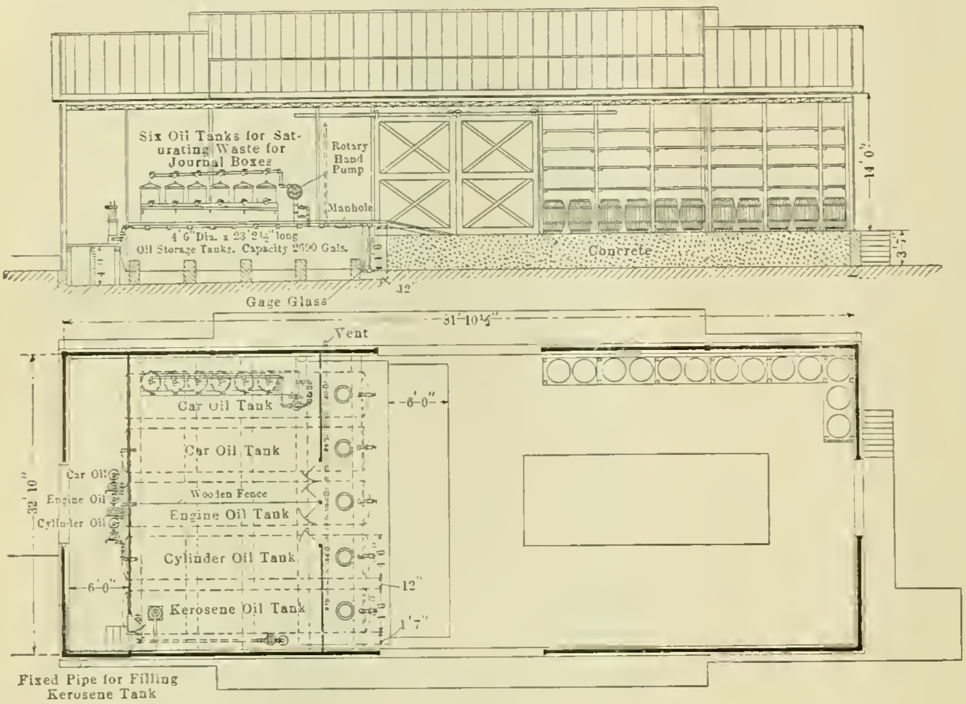
Western Railway Club.—At the regular monthly meeting held on Tuesday, September 20th, a paper entitled "Automatic Connectors for Freight and Passenger Train Cars" was presented by Willis C. Squire.

* See American Engineer, Feb., 1910, p. 69.

A WELL ARRANGED OIL HOUSE.

THE UNITED RAILWAYS OF HAVANA.

Modern oil houses have reached a stage of perfection in this country which seems to leave but little to be desired and it is satisfying to note that foreign railroads are following our example and installing commodious and well arranged structures and thoroughly modern equipment for this purpose.



PLAN OF OIL HOUSE—UNITED RAILWAYS OF HAVANA.

An example of this is the oil house shown in the accompanying illustration, recently completed by the United Railways of Havana, which employs large storage tanks placed beneath the floor and draws the oil through a battery of self-measuring pumps. While, of coure, this house is comparatively small, the equipment is very complete and the arrangement excellent. A large part of the building is given up to room for the storage of oil barrels, since most of the supply is purchased in these receptacles, and this part of the structure has a concrete floor on a level with the platform outside. There are five oil storage tanks placed beneath the raised floor of the oil room proper, each holding 2,690 gallons. Most of the tanks are filled by gravity, the barrels being rolled up an incline over the ends of the tanks where there is an opening, with a very fine screen, giving entrance into each tank. There are two tanks for car oil, one for engine oil, one for cylinder oil and one for kerosene, the latter being provided with an outside filling pipe, since this oil is purchased in bulk and delivered in tank cars.

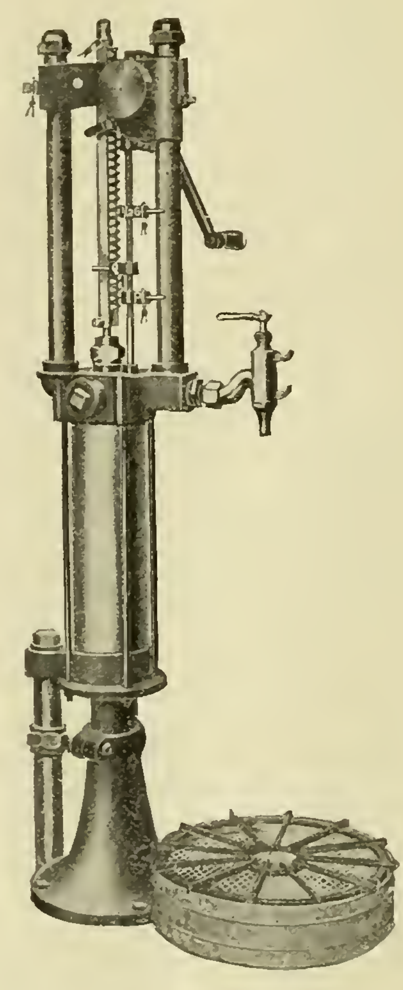
Each tank is provided with a vent pipe carried outside the building for discharging any gases that might accumulate, and each is provided with a storage indicator scaled to gallons, which permits an inventory of the oil on hand to be obtained at any time.

Three of the pumps for the heavy oils are placed together outside of the partition, each connecting to a single tank. These pumps, as well as the whole equipment of the house, were furnished by the Gilbert & Barker Mfg. Co., 80 Fourth Avenue, New York. This pump is of the long distance self-measuring type, which accurately measures in gallons, half gallons, quarts, pints or smaller quantities at a stroke and discharges the oil directly in to the can or receptacle without the use of measures or funnels. It is fitted with discharge registers and a continuous meter, the latter registering to 100,000 gallons, and then automatically repeating. It is provided with a locking device which absolutely prevents an unauthorized person from obtaining any oil. The valves of the pumps are arranged so as to be easily and quickly accessible. It is provided with both side and front discharge and the rod on which the stops are located is threaded, giving a very positive measurement and adjustment. Reference to the illustration will show its general arrangement and construction.

In this oil house there are six tanks located along one side of the smaller room for saturating waste for journal boxes. In each of these tanks is a screen placed about 5 in. above the bottom, which permits the oil to drain from the waste to a trough which carries it to a dripping pan standing at one end of the row. Near this pan is a Gilbert & Barker rotary pump, which has a connection to a large tank in the basement below it, as well as to the pan of used oil. This discharges into any or all of the waste tanks, the arrangement being as is shown in the illustration.

On the other side of the building is a similar rotary pump. This pump is used for filling the kerosene cans, which are to be sent out on the road.

This equipment has proved so satisfactory that similar houses are being built at other points as rapidly as the equipment can be procured.



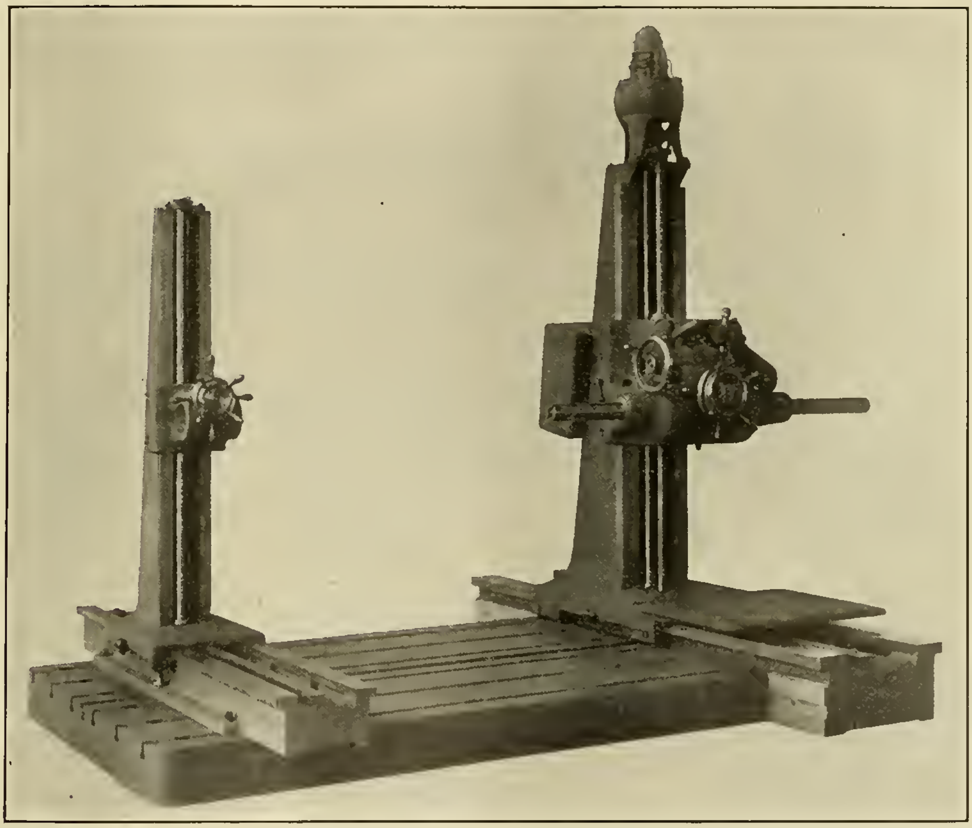
TYPE OF SELF-MEASURING PUMP USED.

HORIZONTAL BORING MACHINE

Rochester Boring Machine Co.

On many classes of work usually done in railroad shops a horizontal boring machine that is also adapted to drilling, tapping and milling operations, is practically a necessity. On this basis the advantages of the machine shown in the illustration will be appreciated at once. Its simplicity, compactness, ease of operation and adaptability, make it practically as valuable for each different kind of work as the regular type of machine. Although, in general appearance, the construction is comparatively light, it is very rigid and is designed for severe duty and for producing accurate work rapidly at the minimum cost.

The machine illustrated is the No. 3 Rochester horizontal, boring, drilling, tapping and milling machine, floor boring type, made by the Rochester Boring Machine Co., Rochester, New York. The floor plate, planed on the top and bottom sides, is provided with the usual longitudinal T slots and is rigidly attached to the heavy and firmly braced slide base by means of heavy bolts.



HORIZONTAL BORING, DRILLING, TAPPING AND MILLING MACHINE—ROCHESTER BORING MACHINE CO.

Graduated scales with vernier readings are provided for locating the saddle and main column in the desired positions, and the outboard support and columns are also furnished with scales giving the same readings. In addition to this, the spindle has a micrometer reading attachment for gauging depths in boring, drilling or milling. The outboard bearing is made with the same vertical and horizontal traverse as the main column, and is provided with suitable bushings for supporting boring bars. It is traversed longitudinally on the base by means of a rack and pinion remaining parallel at all times with the main slide base. The head and outboard column, as well as the main column and its saddle, are traversed by means of concentric hand wheels—both of the column traversing hand wheels being operated either by hand or power. Large and flat bearing surfaces fitted with solid taper gibs, are provided on the saddle, column and outboard support.

All the driving and feed gears are either nickel steel, cast steel or manganese bronze, entirely enclosed in the saddle casting and fully protected. The spindle is so designed that full traverse is obtained without resetting, regardless of its length. It is journaled in long taper bearings of phosphor bronze located at each end of the saddle, adjustable from the outside, and is driven by two large spline keys fitted into a sleeve on which the driving gear is mounted.

Ten speed changes and eight feeds are available, besides four speeds for milling. An interesting feature is that all the feeds are reversible and any desired change can be instantly effected. The motor mounted on top of the column, transmits power through rawhide gearing to the vertical splined shaft, which drives the gearing enclosed in the saddle. A large number of unnecessary gears are eliminated by this arrangement, resulting in a high transmission efficiency.

An attractive feature of the entire machine is the fact that it is self contained and motor driven and can therefore be located anywhere without regard to line shafting. Further, it is very compact and simple, all the mechanism being encased in the saddle, and running in oil, so that all moving parts are thus fully protected and all operations are controlled from one position convenient to the work. The machine can be started, stopped or reversed independently of the motor, each movement being controlled in this manner by a separate lever which operates a friction clutch.

Some of the general specifications of the No. 3 type are given in the following table:

Diameter of spindle	3⅜ in.
Longitudinal traverse of spindle	36 in.
Vertical traverse of saddle	54 in.
No. of spindle speeds	10
Range of spindle speeds	15—200 r.p.m.
Range of speeds for boring and drilling	.01—.25 in.
Max. distance from floor plate to center of spindle	5 ft. 11 in.
Size of floor plate	6 x 9 ft.
Floor space—over all	9 ft. 6 in. x 15 ft. 0 in.
Weight, complete	19,000 lbs.

Freight Service Through the Detroit River Tunnel, which connects Detroit with the city of Windsor, Canada, was inaugurated on September 15th. A ferry was formerly used between these points.

BOOK NOTES

Universal Directory of Railway Officials, 1910. 607 pages, 5¼ x 8¼. Bound in cloth. Published by the Directory Publishing Co., Ltd., 3 Ludgate Circus Bldg., London, E. C. Represented by A. Fenton Walker, 140 Liberty street, New York City. Price, $4.00.

This, the sixteenth annual edition of the Universal Directory, has been very carefully revised and was entirely accurate at the time of publication a month or so ago. It contains the correct name, mileage, gauge, amount of the equipment, name and address of all officers, with their proper titles, of every railway in the world. These roads are grouped according to nations, the first being the United Kingdom, where England and Wales, Scotland and Ireland are separated. Following this are the various countries in Europe arranged in alphabetical order. Then follows the countries in Asia, also in alphabetical order; followed by Africa in the same manner, which in turn is followed by Australia. North America is then taken up, beginning with Canada, followed by Newfoundland and then the United States. Then comes Central America and South America. The roads in each country are numbered consecutively and in the back of the book is a complete alphabetical, personal index of all the railway officials in the world, giving a reference to the number of the road with which they are connected, as shown in the body of the book. To any one who has correspondence or dealings with foreign railways this book is indispensable.

MEN WANTED

Draftsmen.—Several capable draftsmen and estimators by a foundry and machine company near New York City. Salary dependent upon experience and ability. Address T. I.

POSITIONS WANTED

Car and Locomotive Draftsman.—Man with short experience on railroads and with car building companies wishes position as draftsman where opportunities for advancement are satisfactory. Address H. E. E.

Sales Engineer.—College grade; five years' railroad experience, principally in the shop. Address G. E. J.

Shop Foreman.—A practical man whose experience includes drafting room, roundhouse, erecting shop and machine shop work, and who is now foreman of one of the best and most efficient shops in the country, desires a better position where ability will receive reward. Address F. G. Q.

Mechanical Engineer or Chief Draftsman.—Long experience in the drafting room of railways; at present chief draftsman; wishes position on a southern railway. Address P. F. R.

Chief Draftsman or Similar Position.—Technical man, seven years' railroad experience; now leading draftsman on locomotive and electrical work on one of the largest railway systems. Address E. J. W.

Expert on Machine Tool Design.—Has had long experience with the design and building of machine tools and dealing with the problems of shop production. Well equipped for duties as director of a trade school or similar work Address S. C. J.

Designer of Rairoad Specialties.—Man thoroughly experienced in railroad design now chief draftsman of one of the largest systems wishes position with a supply company handling railway specialties, that require a designer of exceptional ability. Address R. L. W.

General Inspector.—Middle-aged man with technical education; 20 years' experience; expert on fuel, tests, spark throwing and front end arrangements; has held all positions from fireman to master mechanic and from machinist to mechanical engineer. Address S. S.

Mechanical Engineer or Sales Engineer.—University graduate; twelve years' practical experience as designing engineer and estimator with locomotive car manufacturers; has been chief draftsman on a large western railroad and is a specialist on steel coach calculations, designs, estimates and details. Address H. D. W.

Sales Engineer, Inspector or Mechanical Engineer.—Graduate in mechanical engineering, with nine years' practical experience in capacity of special apprentice, draftsman, chief draftsman, roundhouse foreman, mechanical inspector and chief estimator with railroads and steel car manufacturing concern. Thoroughly experienced in mechanical lines and exercising of executive ability. Address S. F. W.

PERSONALS

C. M. Stansbury has been appointed master mechanic of the Ocean Shore Railway, with office at San Francisco, Cal.

R. Q. Prendergast has been appointed master mechanic of the Denver & Rio Grande R. R. at Pueblo, Colo., succeeding R. B. Stout.

J. E. McLean has been appointed master mechanic of the Kansas City Southern Ry. at Pittsburg, Kan., succeeding George S. Hunter.

S. B. Burdell has been appointed assistant mechanical superintendent of National Railways of Mexico, with office at San Luis Potosi, Mexico.

C. A. Brandt has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office at Indianapolis, Ind.

C. Harder has been appointed to succeed R. L. Langtim as as mechanical engineer of the Kansas City Southern Ry., with office at Pittsburg, Kan.

J. F. Walsh, general superintendent of motive power of the Chesapeake & Ohio Ry., has had his authority extended over the Chesapeake & Ohio Ry. of Indiana.

J. L. Cunningham has been appointed master mechanic of the New York, Philadelphia & Norfolk R. R. at Cape Charles City, Va., succeeding G. W. Russell, promoted.

E. F. Tegtmeyer has been appointed master mechanic of the Nebraska and Colorado divisions of the Rock Island Lines, with office at Goodland, Kan., succeeding D. H. Speakman, resigned.

William Gill, instead of William Hill, as previously announced in these columns, has been appointed master mechanic of the Iowa Central Ry. at Marshalltown, Ia., succeeding C. E. Gossett.

G. W. Russell, master mechanic of the New York, Philadelphia & Norfolk R. R. at Cape Charles City, Va., has been appointed general equipment inspector, reporting to the superintendent.

W. T. Smith, superintendent of motive power on the Kentucky division of the Chesapeake & Ohio Ry. at Covington, Ky., has had his jurisdiction extended to cover the Chesapeake & Ohio Ry. of Indiana.

C. T. Broxup, locomotive superintendent of the Manila Railroad, at Caloocan, Philippine Islands, has resigned.

G. J. De Vilbiss, superintendent of the motive power of the Hocking Valley Ry.; Lawrence C. Engler, road foreman of engines, and George Milbourne, engineer, were killed in the wreck of passenger train, north bound, on that road near Lemoyne, about eleven miles south of Toledo, on September 12.

FOR YOUR CARD INDEX

Some of the more important articles in this issue arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.

Brake Levers, Design of Amer. Eng, 1910, p. 393 (October).

Curve for the rapid determination of various dimensions of brake levers.

Cars—Passenger Amer. Eng., 1910, p. 381 (October).

Steel Pullman Cars.

Complete description of all steel sleeping, parlor, etc., cars designed by The Pullman Co. The construction is fully illustrated with drawings and photographs. Standard underframe fits 14 types of cars.

Car-Truck Amer. Eng., 1910, p. 398 (October)

Description of a new cast steel truck manufactured by the Pittsburgh Equipment Co. The illustrations show detail of design.

Locomotive-Ash Pan Amer. Eng., 1910, p. 407 (October).

Line drawing and brief description of self-clearing ash pan used on the Pennsylvania Railroad.

Locomotive—Development of British
Amer. Eng, 1910, p. 387 (October).

Article by R. H. Rogers discussing recent changes in locomotive design in Great Britain. Based on personal observations during an extensive visit.

Locomotive—4-6-2 Type Amer. Eng., 1910, p. 391 (October).

Total weight, 256,000 lbs.	Total heating surface, 4,389 sq. ft.
Weight on drivers, 162,000 lbs.	Steam pressure, 200 lbs.
Cylinders, 24 x 26 in.	Traction effort, 31,800 lbs.
Wheels, 80 in.	

Illustrated description of a very large and powerful passenger locomotive built by the American Locomotive Company for the Vandalia Line. Elevation and sectional drawings. Table showing recent service, including coal consumption and speed.

Locomotive—2-8-2 Type Amer. Eng., 1910, p. 405 (October).

Total weight, 263,100 lbs.	Total heating surface, 5,559 sq. ft.
Weight on drivers, 204,450 lbs.	Steam pressure, 180 lbs.
Cylinders, 23¾ by 30 in.	Tractive effort, 45,300 lbs.
Wheels, 57 in. diameter.	

Built by the Baldwin Locomotive Works for the Oregon Railroad & Navigation Co. Designed to burn lignite. Illustrations include front end, grates, firebox and the Collins pedestal binder.

Locomotive—Performances on Grades of Various Lengths
Amer. Eng., 1910, p. 394 (October).

Article by Beverley S. Randolph investigating the effect of the length of grade on locomotive performance.

Locomotive—Water Tube Fire Box
Amer. Eng., 1910, p. 411 (October).

Type of watertube firebox in successful use on the Northern Railway of France. Illustrated description.

Locomotive Terminals—Oil House
Amer. Eng., 1910, p. 416 (October).

Brief illustrated description of a well arranged oil house on the United Railways of Havana.

Locomotive Valve Gear Amer. Eng., 1910, p. 408 (October).

A new radial valve gear designed by the Hobart-Allfree Co., based on principle of both the Marshall and Walschaert types. A full illustrated description, including dimensioned drawings.

Machine Tools.—Hollow Chisel Mortising Machine
Amer. Eng., 1910, p. 413 (October).

Illustrated description of a new hollow chisel mortising and boring machine. Built by the Atlantic Works, Inc.

Machine Tools.—Horizontal Boring Machine
Amer. Eng., 1910, p. 417 (October).

Illustrated description of a combined boring, drilling, tapping and milling machine of the horizontal type. Designed by the Rochester Boring Machine Co.

Shop Devices Amer. Eng., 1910, p. 397 (October).

Dies for shearing squares on ends of staybolts.

Brief illustrated description showing dies used at the Readville shops for shearing the squares on the ends of staybolts.

Shop Devices Amer. Engr., 1910, p. 406 (October).

Valve stem turning and rolling tool.

Brief illustrated description of combined tool for turning and rolling a valve stem.

Superheater—Fire Tube Amer. Eng., 1910, p. 403 (October).

Used on Great Western (England) Railway. Designed by G. J. Churchward, locomotive superintendent. Six 1 in. tubes in each element. Elements connected to a horizontal header in smoke box. Description fully illustrated.

Train Resistance Formula Amer. Eng., 1910, p. 407 (October)

Formula suggested by Lawford H. Fry, based on Prof Schmidt's experiments. It includes factors for both weight and speed of train in one formula.

CATALOGS.

Drawing Instruments.—Kolesch & Company, 138 Fulton St., New York, are issuing a small pamphlet describing the "Richter" precision instruments for the use of draftsmen and surveyors.

Controllers.—The General Electric Co., Schenectady, N. Y., has recently issued Bulletin No. 4761, which goes into some detail in describing the Sprague General Electric type "M" control system.

Vanadium Steel.—The Carnegie Steel Co., of Pittsburgh, Pa., has issued a small catalogue giving the process used in treatment of vanadium steel, including tables of the physical properties of the various types and their uses.

Railroad Scales.—A 36 page catalogue has recently been issued by the Government Standard Scale Works, Terre Haute, Ind., describing various styles of new scales, including standard railroad track scales with capacity of 60 tons and up.

Snow Plows.—Bulletin No. 1005, isssued by the American Locomotive Co., New York City, describes its rotary snow plows very fully, including illustrations of these plows at work making cuts 24 ft. deep. It also gives a list of railroads that are users of this design of rotary plow.

Small Generators.—The Triumph Electric Co., Cincinnati, O., has recently issued new Bulletins Nos. 391, 411 and 421, describing its direct current steel frame generators and motors and small direct connected generator sets with vertical type engines. The capacity of these machines is up to 100 k. w.

Tool Holder.—A small circular is being issued by the G. R. Lang Co., Meadville, Pa., describing the various styles of its new tool holder for shapers, boring mills and lathes. It includes a number of illustrations showing the application to the various machines, and adaptability for all classes of work.

Metallic Packing.—This is the subject of a new 40 page catalogue issued by the Holmes Metallic Packing Co., of Wilkes-Barre, Pa. It contains a description of packings for all purposes, with illustrations showing their application and a large amount of data on the life of these packings in service on locomotives.

Conveying Machinery.—Coal handling equipment and machinery, the subject of a new Bulletin No. 42, issued by the Jeffrey Mfg. Co., Columbus, O., contains a number of illustrations showing the various styles of coal handling machinery, one section being devoted to locomotive coaling stations and their equipment.

Air Compressors.—Publication 891, issued by the National Brake & Electric Co., Milwaukee, Wis., consists of a 68 page catalogue with tables and a large number of reproductions from photographs, and diagrams showing National motor driven air compressors and also some well designed portable air compressor outfits.

Valve Grinder.—The catalogue issued by the Turner Machine Co., Philadelphia, Pa., illustrates and describes some of its automatic valve grinding machines, including moulding machines and foundry equipment. The valve grinding machines are valuable in saving labor and time, especially when used for grinding air brake cocks.

Portable Electric Drills.—The Sprague Electric Co. has issued small bulletins describing its electric drills for direct and alternating current. The power required is roughly 104 watts when operating a ⅛ in. drill in machine steel at a feed of about 4 in. per minute. There are also illustrations and descriptions of small motor driven disc and propeller fans.

High Speed Drills.—Catalogue No. 10 on this subject is being issued by the Celfor Tool Co., Railway Exchange, Chicago. The catalogue is attractive and well illustrated, going into detail in the process of manufacture of these drills. It contains a large table with valuable information regarding the feed and speed of the drills for cast iron, medium and hard steel.

Drills and Horizontal Boring Mills.—The Fosdick Machine Tool Co., Cincinnati, O., is issuing an attractive and well illustrated catalogue giving descriptions and complete specifications of its universal and plain radial drills, with arms up to 5 ft. in length, and also various styles of horizontal boring, drilling and milling machines, which are adapted for all classes of work.

The Mechanigraph.—Topping Bros., 122 Chambers St., New York City, have recently issued an attractive catalogue describing and illustrating their new process of making drawings transparent so that blue prints can be made directly from the original drawing. It also describes a machine for renovating old worn out tracings without affecting the original lines of the drawing.

Steel Car Paint.—The Joseph Dixon Crucible Company of Jersey City, N. J., has just issued a very attractive little booklet of envelope size on their paint for steel cars. The booklet not only goes into the merits of the Dixon paint for this service, but illustrates a number of different types of steel cars upon which Dixon's paint has given excellent service. The booklet also contains color chips showing the four colors in which this car paint is made.

Non-Corrosive Sheet Metal.—A comprehensive treatise on the corrosion of steel and iron is issued by the Stark Rolling Mill Co., Canton, O., makers of Toncan metal. The treatise sets forth, clearly and concisely, the facts concerning corrosion and rust, their causes and remedy. Some interesting comparisons are made of old-time iron and modern iron and steel, showing the effect of purity, homogeneity and density on its life and including the uses of a rust-resisting product like Toncan metal.

High Pressure Blowers.—Catalogue No. 175, issued by the B. F. Sturtevant Co., Hyde Park, Mass., illustrates and describes a variety of horizontal impeller type blowers suitable for gas or oil burners, including annealing furnaces and metal melting furnaces. Some of these blowers are direct connected to engines or motors by a flexible coupling of leather links to take care of any defects in alignment and end thrust. The capacity, at 1½ lbs. presssure, ranges from 25 to 15,000 cu. ft. per minute with 200 to 800 revolutions per minute, but the blowers are recommended for pressures up to 5 lbs.

NOTES.

United Engineering & Foundry Co.—Otis H. Childs, chairman of the executive committee and a director of this company, of Pittsburgh, Pa., died on August 22.

Safety Car Heating & Lighting Co.—It is announced by this company, of 2 Rector St., New York, that John J. Malloy has been appointed general purchasing and supply agent and will have charge of all departments heretofore under the direction of Mr. Pye.

S. F. Bowser & Co.—This company, of Fort Wayne, Ind., announces the appointment of Edward H. Barnes at Atlanta, Ga., as representative of the Southern district. Previous to his appointment Mr. Barnes was associated with the Bass Foundry Machine Co., Fort Wayne, Ind.

Homestead Valve Manufacturing Co.—The above company, of Pittsburgh, Pa., has opened an office at 1135 Park Row Building, in New York City, N. Y., in charge of Frank Boyle, for the sale of Homestead valves in this territory, and will carry a stock of valves for immediate delivery.

Rockwell Furnace Co.—To accommodate the increasing business in the Middle West, this company, of 27 Cortlandt St., New York, has opened a branch office in the Fisher Bldg., Room 718, Chicago, Ill. The office will be in charge of A. L. Stevens, an experienced furnace engineer, and will enable the company to give more prompt attention to the Western trade.

Firth-Sterling Steel Co.—E. S. Jackman & Co., agents for the above company, announce that James A. Sherwood, who for the past five years has filled a responsible position in the sales organization of this company, has been appointed the Canadian agent for Thomas Firth & Sons, Ltd., Sheffield, England. Mr. Sherwood will have full charge of the Canadian trade beginning October 1, with headquarters in Montreal.

Wells Bros. Co.—The above company, of Greenfield, Mass., announces the opening of a new store in New York City at 90 Worth St., and the stock of tools which was formerly carried at 126 Chambers St. has been moved to the new store. A full and complete stock of screw cutting tools will be carried, so they are ready for immediate delivery on special rush orders. The new store will be managed by Chas. H. Coe, formerly with A. Z. Boyd, of New York City.

H. W. Johns-Manville Co.—Owing to the increased business in the vicinity of Atlanta, Ga., and Rochester, N. Y., the above company, of 100 William St., New York, has recently found it necessary to open a new office in each of these cities. The Atlanta office is located in the Empire Bldg., in charge of W. F. Johns, who has been traveling in this territory for the company for a number of years, and the Rochester office is located at 725 Chamber of Commerce in charge of H. P. Demoine, formerly with the Buffalo branch of the company.

American Locomotive Co.—The annual report to the stockholders of the company for the fiscal year ending June 30 has recently been issued by the board of directors. It is interesting to note that the net earnings were $2,597,949, as compared with $1,342,671 in 1909, and the surplus was $334,758, as compared with a loss of $762,860 last year, showing an improvement in the net results of $1,097,619. At the beginning of the fiscal year the company had unfilled orders on its books amounting to $6,150,000. And on July 1st, 1910, the amount was $17,550,000.

Locomotive Boilers

A REVIEW OF REPORTS PRESENTED AT THE RECENT RAILWAY CONGRESS ON THIS IMPORTANT SUBJECT, WHICH INDICATE A LACK OF UNIFORMITY IN PRACTICES AND LITTLE PROSPECTIVE IMPROVEMENT.

A thorough consideration of the question of improvements in locomotive boilers brings to light curiously divergent views entertained by designers, and clearly indicates, from the standpoint of universal application at least, that many problems must still be solved before general uniformity in prominent details of construction will be attained. In American practice it is admitted that the latter condition practically prevails, but in comparison with ideas covering the same operations which are entertained in foreign countries the difference exhibited is startling to a degree, when the similarity of the work which the apparatus must perform, no matter where located, is borne in mind.

It may necessarily be regarded as elementary in view of this treatment to assert that primarily a boiler is intended to make steam in sufficient volume for the work at hand, and that this is its mission in whatever country, but some freaks in its design and some peculiar variations in the operations connected with its maintenance as exhibited in various lands might almost impel the thought that a different appliance was under consideration.

This was well exemplified during the recent Eighth Session of the Railway Congress when reports on boiler design and the care of boilers were submitted from railroads in every country of the world, with the possible exception of China, Egypt, Greece, Dutch Indies and the Congo. A careful reading of these voluminous bulletins indicates that the greatest divergence of opinion exists in the treatment of many items entering into boiler construction, but particularly in connection with the material and the shape of fireboxes, the material for tubes, and their mode of application and repair; the practicability or utility of superheaters, and of the value of water tube boilers. Many examples of curious practices were also presented, but it is thought that a discussion of the above principal features may prove of greater interest.

To explain the assertion that uniformity in detail of construction is present in this country it may be well to recall that the type of boiler generally used in the United States and Canada is that with a round top firebox of what is termed the extended wagon top style, in which the diameter of the circular portion of the firebox and the rear portion of the barrel is larger than that of the front portion of the boiler. Usually the course of the boiler next to the firebox and the front course of the boiler are both cylindrical in form, joined together by a middle taper course. The dome is usually placed on the course next to the firebox. A few of the larger railroads, such as the Pennsylvania lines, including allied roads, and the Great Northern are using the Belpaire firebox, while others, such as the Illinois Central and Canadian Pacific railways, have used the Belpaire more or less extensively, but in each case the latest engines have been equipped with round top boilers.

As very clearly put by H. H. Vaughan in his report to the Railway Congress on American practices the extensive use of the round top fire-box is explained by the results from it being on the whole satisfactory. The Belpaire form of box has, no doubt, an advantage in the fact that the stresses in the various plates and stays can be accurately determined by calculation, whereas in the round top boiler, especially one of the radial stayed type, these stresses cannot be determined with the same degree of accuracy. The service, however, of many thousands of round top boilers has fully demonstrated the safety of this type when properly constructed and maintained, and has proved the correctness of the calculations by which their strength is determined. The Belpaire fire-box is somewhat more expensive to construct than the round top, and adds a certain amount to the weight of the boiler without a corresponding increase in the heating surface, hence the largely predominating use of the simpler round type.

Round Top Boiler the Standard.

In view of the fact that this latter construction is so greatly in the majority on American roads, it may be assigned as the "standard" type, and in this connection it is of interest to review briefly the opinion in which it is held abroad. It is quite singular, in view of the popularity which the round top boiler enjoys here, to find it utterly repudiated in France. The chief French railways have adopted Belpaire boilers on all their more recent locomotives, with the exception that the Paris-Lyons-Mediterranean is designing a single Pacific locomotive with a round top boiler. M. Nadal, Chief Engineer of the French State Railways, does not explain why the round top boiler is not preferred, contenting himself merely with the non-committal statement, "Each of these two types has its own advantages and disadvantages, and these have been the subject of much discussion. It must finally be recognized that neither the one nor the other is very definite, but the round top boiler is more extensively used, and it appears to be preferable in the case of large boilers."

As an illustration of the extensive use of this type abroad it may be mentioned that in Austria-Hungary, Roumania, Bulgaria, Servia and Turkey the boilers of the more recent locomotives are round topped. Belpaire boilers are occasionally to be found on older locomotives in those countries, as well as flat tops of the Becker and other similar types. In Russia it is practically the standard, and is generally preferred in Holland, Sweden, Switzerland, Bavaria, Prussia, Denmark and Norway. Great Britain exhibits many boilers of the Belpaire type, but a careful analysis indicates about a two-thirds majority in favor of the round top.

It is unfortunate, in view of the interest which so generally attaches to boiler construction at this time, that with the exception of what is contained in Mr. Vaughan's valuable paper the reporters of the various countries at large did not assign any definite reason for the preference toward either type. It is confidently believed that locomotive design in England at present is in the throes of a radical metamorphosis: this based on the many and diversified experiments which all roads are conducting, therefore reticence may be reasonably looked for in that quarter, but in the instance of the other countries the same condition does not apply, and there is no real reason why the conclusions which dictated the choice in favor of the round top boiler should not be apparent. However, enough has been gained at least to establish the fact that this latter type is overwhelmingly in the majority all over the world, and that in one item, the outer shell, there is a prospect of ultimate uniformity.

Wide Latitude in Firebox Material.

In the matter of fireboxes proper great diversity of opinion exists in regard to the material from which they should be made. They are exclusively of steel in this country, but the preference for copper abroad is seemingly too deeply rooted to be overthrown for many years. In Austria-Hungary, Roumania, Bulgaria, Servia and Turkey copper is generally employed. Trials of iron fireboxes have been made on several railways therein, and some are still the object of trial at present. For instance, the Austrian State Railway has a number of ingot-iron fireboxes, and also iron water tube boxes of the Brotan system. Both are said to give good results in the trials which have now been going on for four or five years.

A number of years ago the Hungarian State Railway tried five fireboxes made of ingot iron, but these had to be taken out after they had been in use a comparatively short time and replaced by copper fireboxes, because they showed cracks and serious rusting in their lower portions. A firebox on that road is at present being fitted with a crown sheet of ingot iron. The iron fireboxes also did not give good service on the Austrian North-Western Railway, and had to be taken out because cracks formed. The Austrian Southern Railway has experimented with ingot iron fireboxes made from corrugated plate, on the Hasswell system, and also for a short time with copper fireboxes having the tube plate of ingot iron. The results, however, were unfavorable, as cracks and fissures appeared: in some cases during the fitting, in others while in use, and it was found that the fuel used (coal) acted on the material and produced a chemical change which affected the strength and durability of the plate to a material degree. These trials were accordingly stopped, and the copper firebox permanently re-established.

Copper practically rules in Russia for this purpose, but extensive experiments have been made with other material. Fireboxes with iron side sheets may be encountered on the Viadicaucasus line, which has 302 locomotives out of 809 so equipped. Up to the present the results are said to have been good, with the exception that the use of hard water results in corrosion of the iron plates. Eight other roads in that country are using iron as an experiment for the fireboxes, partly in the form of full sheets, and partly for tube plates and back plates The results of these experiments vary; that is, they are good on lines where the water has not more than 24.7 English degrees of hardness, and bad where the water has from 24.7 to 111 degrees of hardness. The iron plates require more looking after than the copper owing to leaky tube troubles, and apparently this consideration will result in the total abandonment of any material other than copper.

In France the fireboxes remain of copper and there is little likelihood of any change, although there are isolated instances where several railways are experimenting with boxes made entirely of steel following the American practice. Two locomotives on the French Northern were recently fitted up in this way, but beyond the statement "The application is too recent to enable any conclusions to be drawn as yet," there is no augury for the future. Although the Midi has fitted a considerable number of engines with steel crown sheets which are giving good results and afford satisfaction, the French engineers retain prominently in mind the fact that the Paris-Lyons-Mediterranean a dozen years ago tried fireboxes made wholly of steel with very unsatisfactory results owing to the cracks which very quickly formed in the stayed portions.

During the last two years the French State Railway has been trying on two locomotives having working pressure of 185 pounds and of 213 pounds, respectively, tube plates with that part which receives the tubes made of steel, and the lower part made of copper. In this ingenious but certainly questionable arrangement the two parts of the tube plate are joined by a lapped seam, the copper being on the side toward the fire, so that it can be caulked, and with the seam a little higher than the arch. Up to the present time these compound plates are said to have given good results, but it is necessary to give the seam a frequent caulking, and some of the rivets have been replaced.

Steel fireboxes have not been found satisfactory on the Italian State Railway where they are embodied in the American built engines which are running there. These engines have ½ in. tube plates and 11/32 in. crown and side sheets. In referring to the performance of these boxes M. Nadal states that the results have not been satisfactory, without further comment.

Failure of Ingot Iron Boxes.

By far the most interesting experiments, however, to determine the most enduring and in general satisfactory material for this purpose were conducted on the Bavarian, Saxon, Dutch and Prussian railways, and the general result has been a return to the former practice where copper was universally employed. The Bavarian State Railway was supplied in 1900 and 1901 with two freight and two express engines built in the United States, which had fireboxes of ingot iron. The boxes in the freight engines had to be renewed after four years, and again after three years. The second time copper fireboxes were substituted. In regard to the express locomotives, one had its iron firebox replaced after three years by a copper box, and the other after six years. The ingot fireboxes gave good results when first used; afterwards corrosion appeared inside, particularly at the points in contact with the fire, and also cracks, which started from the staybolt holes. These latter enlarged at an alarming rate, and made it necessary to dispense with the boxes. Further experiments have not been made by this road.

Trials were made with ingot iron boxes on the Saxon State Railway during 1892-1902, but in consequence of corrosion and pitting the copper came quickly back into its own. This material had also a trial on the Dutch and Danish State railways, but little durability was shown and consequently no further experiments were made with them. At present this latter line is conducting tests with iron tube plates in copper boxes, and also with fireboxes made of "hard copper" and "special copper," this being supplied by the firm of Heckman of Duisburg.

Fireboxes made of ingot iron and nickel copper have been tried on the Prussian-Hessian State Railway. Trial previously made with ingot iron fireboxes gave results which were so unfavorable that in 1896 it was practically decided that such fire boxes should not be used. Their average life was only three years, and much less under unfavorable conditions, particularly where bad water was present. In one instance the box lasted only six months. It was also found that during use cracks appeared, not unfrequently in the firebox walls. Not only was it difficult to repair these, but in a number of cases it involved much expenditure and loss of time. Although the use of ingot iron fireboxes has been again recommended in certain quarters, it is practically assured that nothing will materialize, and chiefly on account of the bad result obtained in Bavaria.

Continuing its experiments, the Prussian-Hessian State Railway has installed fireboxes of nickel copper in a simple freight engine and a compound freight engine. The nickel proportion is about 15 per cent., and the boxes were applied in the summer of 1905. When the simple engine was carefully examined in 1908 it was found that the side corners of the tube plate had been considerably affected by the fire, and several rivet holes showed cracks; in particular the left corner of the back plate was defective. In order to make repairs permitting the use of the locomotive it was necessary to apply copper patches 19 in. long at the damaged spots. The side sheets and the crown sheet were still in good condition.

No report on the condition of the compound engine which was fitted out at the same time is given, but from the condition of the other engine the conclusion may readily be drawn that nickel copper is an unsuitable material for fireboxes, for although it costs much more, it presents no advantages.

Prohibitive Cost of Nickel Copper.

Figures assist facts, and in passing it may be well to slightly comment on the enormous cost of nickel copper over ordinary copper, and the cost of the latter is reckoned in United States as sufficient to render its use prohibitive. While recently in France the writer made a calculation in the shops of the Chemin de Fer du Nord that if a nickel copper firebox were to be applied to an engine waiting there to receive one of ordinary copper the *increased* cost would be 4,800 f, or nearly $1,000. This is merely the cost of material and does not consider the labor and the increased cost of the latter in this connection is no inconsiderable factor, as the nickel copper is much harder, takes longer to work, and must be handled with exceeding care in the preliminary operations.

Copper used for fireboxes in foreign countries generally is either smelted or obtained electrolytically, but it must be regarded as doubtful whether electrolytic copper is quite as good as smelted copper, as regards durability and resistance to burning, particularly in the corners where this trouble is usually in evidence. It is interesting to note in this connection that the Prussian-Hessian State Railway specifies that the copper plate used for fireboxes shall have an ultimate tensile strength of at least 31,200 lbs. per square inch of original cross section, and an elongation of at least 38 per cent., measured on a length of 7⅞ in. The metal to be tested may not be heated, and the test pieces have accordingly to be cut and machined cold.

This somewhat lengthy comment on the subject of fireboxes alone was inspired through a considerable respect for the costly experiments which are frequently observed abroad and which have for the sole end in view the acquisition of the proper material regardless of the cost of the tests or of the future permanent costs which would be imposed through the substitution of such material as nickel copper. The matter was quickly settled in the United States, as we all know, where steel is universally used for fireboxes, but whether it is considered that the problem has been solved is not within the province of this article to discuss. Fireboxes last on an average about ten years in this country in good water districts, and from two to four years in sections where the water is bad. In view of the high earning capacity of locomotives at home this, no doubt, is considered to be a good return for the investment.

It would certainly appear on its face that firebox steel of good grade, for instance, taken at random, the Pennsylvania or Baltimore and Ohio specification, should prove adequate for the much lighter service in the old country whose worst water does not compare with certain portions of the United States, and where locomotives are acccorded much better maintenance, if the last must reluctantly be said. However, the fact remains that with the single exception of Spain, fireboxes made wholly of steel are not in favor abroad, but it may be that what is being accomplished there on a small scale may attract sufficient attention to give them a thorough and proper test. In 1907 the Lorca-Augilas line of that country fitted, as an experiment, two boilers with steel tube plates, and as these gave satisfactory results in every way, it was decided to adopt all steel fireboxes, the first of which was taken into use in August, 1908, of course too short a life to warrant any expression from that road concerning their permanent retention.

Decline of the Brass Tube.

Boiler tubes in this country are almost exclusively of charcoal iron, while abroad the usual lack of uniformity so noticeable in connection with other details looms with equal prominence. On the roads of Belgium, Spain, Italy and Portugal and France they are of iron, of mild steel or of brass. In Russia the material used is exclusively ingot iron. In every country there is a discrepancy and no agreement in regard to the best practice. One thing, however, has been clearly established through the work of the last Railway Congress; and that, the gradual decline of the former time-honored brass tube.

Fortunately in the consideration of this item reasons are given for their retirement, of which the following are presented: The railroads of Austria-Hungary, Roumania, Bulgaria, Servia and Turkey agree that the use of brass tubes was abandoned, and quite apart from their high cost, because when lighter fuel (lignite) was used, the tubes became worn quickly and irregularly, until they finally collapsed and broke, consequently the above countries have adopted ingot iron or mild steel. In Russia they are made exclusively of ingot iron, through the contention that this material, which is much cheaper than brass, works very well, requires no special maintenance, and, as regards conductivity, is practically equivalent to brass.

In France mild steel is exclusively used, and for these reasons: Mild steel tubes cost less than brass tubes; they produce smaller strains in the tube plates, because the coefficient of expansion of steel is less than that of brass; brass tubes do not resist pressures of over 170 pounds per square inch satisfactorily; the ends of the steel tubes are very easily repaired by autogenous-soldering methods; and, the firebox ends of tubes made wholly of brass are rapidly corroded; safe ends of copper and ferrules have to be added, which ends are expensive and give rise to fracture. It is agreed in France that the steel tubes become pitted and corroded more quickly than brass tubes, if the water is of bad quality, but these results are not apparent, as the water is uniformly good.

Variable Flue Setting and Spacing.

So far as the setting of tubes is concerned practices abroad do not vary greatly with those in evidence in this country. The railways which use steel tubes do not use ferrules, while those who have kept brass tubes resort to this latter practice in order to protect the end of the tube against the action of the fire and to improve the tightness. In this case the thickness of the ferrule varies between 3/32 in. and 5/32 in. The steel tubes employed are nearly everywhere beaded, at all events in the firebox end, and often at the smoke box end. In the instance of brass tubes the practice of beading is much less general. On the Belgian State Railway the brass tubes are beaded, while this is not done on the Italian railways and on the majority of secondary railways. But the Italian railways have now for quite a considerable period been trying special ferrules with a flange, this in order to protect the ends of the tubes against the flames, and this would show that such a protection is considered necessary.

Flue spacing may perhaps be of greater interest than the mere setting of the tubes in the sheet, which, as has been said, does not vary greatly from American practice, and in this item also will be found a remarkable lack of uniformity; in fact, it may be said that the procedure is practically at random. It would appear, indeed, from even a casual examination, that the order in which the tubes are set varies so much on different railroads that little importance is attached to the matter in general. On the French Eastern the tubes are set in, and expanded in horizontal rows, alternately from right to left, and from left to right. On the French Northern the work is done in vertical rows, starting from the middle, and then doing a vertical row on the right and on the left alternately, but always going from the top to the bottom. Experience would seemingly show in this procedure that to drive the metal toward the edges is the best for avoiding deformations of the tube plate. On the Midi Railway the work is done in horizontal rows, starting from the bottom. On the Paris-Lyons-Mediterranean it is performed in vertical rows, starting from the extreme left, or the extreme right row, but always starting at the top. On the Belgian State Railway, and many others throughout Europe, no particular order is adopted.

It will be noted after careful consideration of these vagaries in tube setting that in this regard conditions approach closer to our own practice than any which have been heretofore touched upon. For instance, some roads in the United States insist that all tubes shall be beaded in the front end; others that only a small proportion be beaded in "x" fashion across the front tube sheet, while others contend that it is a waste of money to bead them in the front end at all. In the back end, particularly in new construction, it is sometimes insisted that all tubes be prossered, but instances are not uncommon where the railroad inspector stationed at the builder's shop has been instructed not to allow the use of a prosser or any similar contrivance.

The Brotan Boiler Popular.

Experiments with water tube boilers on an extensive scale are clearly indicated in the reports from foreign roads, a departure which has received little or no encouragement in American practice. The protracted and expensive repairing of boilers, making it necessary to lay up the locomotive for weeks, led Mr. G. Noltein, a prominent Russian engineer, to a consideration more than twelve years ago of the possibility of replacing the usual locomotive firebox by one of new type with water tubes. The idea thus originated with Mr. Noltein, although he was delayed in his experiments until Chief Inspector Brotan, works manager of the Austrian State Railway, brought out the boiler which now bears his name.

This boiler was unquestionably well designed and carefully thought out. It is the only kind of water tube boiler used in Austria-Hungary, Roumania, Bulgaria, Russia, Servia, Turkey and other countries. The construction of this boiler is no doubt generally understood, but it may be briefly described as a combination of fire tube and water tube boiler, for the barrel, together with the smoke tubes and the two tube plates is of the same design as in the ordinary locomotives used until now, while the firebox can be considered as a water tube boiler. A further peculiarity of the Brotan boiler is that a steam chamber and upper drum are placed above the barrel, and the firebox. The firebox and the firebox shells of the ordinary boiler are replaced by vertical water tubes made of iron and placed next each other, extending from one common foundation ring to the upper boiler. These tubes, which are spaced closely, form the walls of the firebox, while two other tubes enable the water to flow from the barrel through the foundation ring and the firebox tubes into the upper drum.

Having two tubes connected with the barrel has made it possible to avoid connecting both longitudinal sides of the foundation ring or tube. This is an appreciable improvement over the original design, where only one tube was used. In the present design, now in great favor, the foundation tube consists of but four parts, which are united by three flange joints into one whole.

Advantages Claimed for Water Tubes.

As water entered the fire box water tubes from below, steam is able to rise very freely without forming vortices; and, as the mixture of steam and water which is in the tubes has a materially lower specific gravity than the entering water, the circulation of the water is much facilitated in this design. The quicker and more economic production of steam in the Brotan boiler has been attributed to this circumstance, together with the thinner fire box walls. It has been shown, however, through conclusive tests that the thickness of the walls of the heating surface is of quite subsidiary importance; consequently the more economic working of the Brotan boiler can only be attributed to the better circulation of the water and to the greater direct heating surface which results from the circular cross-section of the tubes and from their staggered arrangement.

These boilers are highly regarded in all foreign countries where employed, in particular the results obtained on the Moscow-Kazan Railway show that Mr. J. Brotan's assertion that a boiler of this design works more economically than the ordinary boiler has been fully proved. The reports in question indicate that the Brotan boiler gave an economy of 14.43 per cent. in the coal consumption, this result being so surprising that it was checked in a number of carefully executed trial runs before being accepted as conclusive.

That this novel design possesses many points of merit goes without question, and the continued success of the type cannot fail in shortly attracting universal attention. This combination of fire tube and water tube boiler has a very large water space and a sufficiently large steam space; the water circulates well and consequently evaporates quickly, hence the formation of scale in the tubes is effectively prevented by the active movement of the water. The system of construction is strong, and there are no particular difficulties in the maintenance, at least whatever these may be they are less than with the locomotive boilers used abroad, containing a copper fire box. The boilers give good results as regards steam production and the keeping up of pressure, items of special importance in the case of long runs.

Superiority of Brotan Type.

General conclusions from many roads in the countries named, which are using this type of boiler are as follows:

First.—With proper attention the Brotan boiler works reliably and economically. The smaller amount of water consumed by locomotives equipped with Brotan boilers shows, contrary to earlier expectations in connection with the formation of steam in the boilers, that drier steam is produced than by locomotive boilers of the ordinary pattern.

Second.—As the two tube plates are riveted to the barrel of the boiler which does not give in the longitudinal direction, it appears that the fire tubes are more rigid in the boiler than is the case in the usual system of construction, and which gives them a tendency to leak.

Third.—Repairs found to be necessary in the Brotan boiler can be carried out easily and quickly, this being a positive arrangement in this system of construction.

Fourth.—The Brotan fire box gives the frame no support and consequently it is necessary to provide other stiffening for it.

Fifth.—The Brotan boiler works more economically than the ordinary boiler. The calculated coal economy is 2 to 5 per cent., but in practice it has been found to be 10 to 14 per cent. The reasons for this discrepancy have not as yet been ascertained with certainty.

Sixth.—As the majority of boiler explosions are caused by a defective condition of the fire box walls, the Brotan boiler may be looked upon from this point of view as safer.

Seventh.—The Brotan boiler is about 15 per cent. cheaper than the ordinary boiler.

Eighth.—The general results obtained show that the use of the Brotan boiler is to be recommended.

There is little doubt but that the United States will hear much more of this type of boiler. A careful review and study of all reports presented at the last Railway Congress clearly indicate it to be the most sucessful of all radical departures in design during the past few years. It seems to have solved the problem of fire box troubles, which has not been the least vexatious to confront American railway management.

Other interesting points touched upon, and in some instances discussed at length, were superheaters, concerning which the general opinion abroad favors their retention and further development; rocking grates, the adoption of which is generally advocated, and washing out of boilers. In this latter detail the usual variation of opinion was in evidence, but the majority favored cold water for the operation.

These are the principal features in connection with boiler design and improvements touched upon in the reports submitted to the last Railway Congress, and it is believed that no more interesting matter has ever come before that body. They point conclusively to what this article at first intimated: that items of boiler construction presumed to be definitely settled in this country are still in the experimental stage abroad, and they indicate that a continuance of these experiments, particularly in the development of the water tube boiler, may unearth at any time something which can be advantageously employed in our own practice.

THE ELECTRIC RAILWAY CONVENTION

The annual convention of the American Street and Interurban Railway Association, held at Atlantic City, October 10-14, was the most successful in the history of the association and reflected great credit upon everyone who assisted in the arrangements. The total number of members and guests was considerably over two thousand, representing the various accountants, engineering, claim agents, manufacturers and traffic and transportation associations which are affiliated with the American association.

The various exhibitors numbered upwards of two hundred, and in variety the exhibits included every possible item of interest to street railway men. These occupied three buildings, and also the aquarium court and the machinery hall of the million dollar pier. The track exhibits were placed on a temporary track, 250 feet long, parallel to the boardwalk and extending north to the pier. It is doubtful if a more generally attractive display has ever been previously gathered in the convention city. No hitch whatever occurred in connection with any exhibit, all being ready on the opening day of the convention.

The following officers were elected for the ensuing year: President, Arthur W. Brady, president Indiana Union Traction Co., Anderson, Ind.; first vice-president, Thomas N. McCarter, president Public Service Railway, Newark, N. J.; second vice-president, George H. Harris, Washington Railway and Electric Co., Washington, D. C.; third vice-president, Charles N. Black, vice-president and general manager United Railroads of San Francisco; fourth vice-president, W. G. Ross, managing director Montreal Street Railway.

TEST TO SHOW THAT NEW CHILLED WHEELS ARE NOT TRULY ROUND

That new chilled car wheels ordinarily embody two distinct defects, uneven chill and tread not truly round, was somewhat prominently featured by Thomas D. West in a paper before the recent meeting of the American Society for Testing Materials. This paper was of value in attracting attention to these conditions, especially the latter, which is not believed to generally receive much consideration.

It is, of course, well known that perfection has not been attained in either detail. The chilled question, in fact, has been made a special study by many qualified experts, among them the late Dr. C. B. Dudley, and many changes in existing methods of casting have been advocated to insure against variation in the depth of the chill. The detail of true circular form, however, has not been given so much attention, and had it not been for careful tests recently made by S. K. Dickerson, assistant superintendent of motive power, and H. E. Smith, engineer of tests, of the Lake Shore and Michigan Southern railroad, the actual status of the matter would still remain undefined.

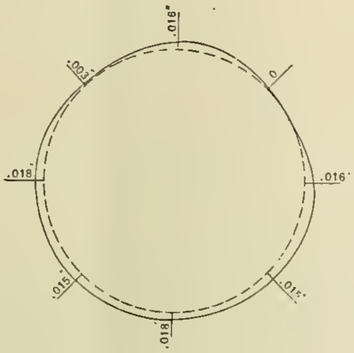


FIG I.

FIG. 2.

FIG. 3.

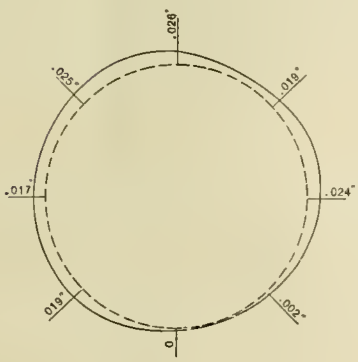


FIG. 4.

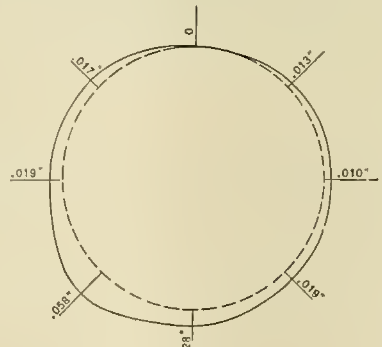


FIG. 5.

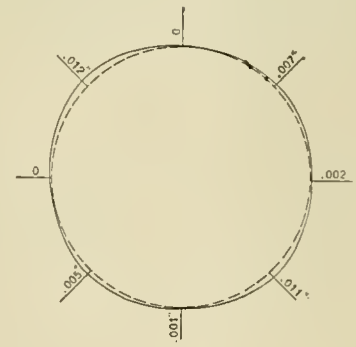


FIG. 6.

Through these tests it has been possible to portray, as the diagram graphically indicates, the measured variation from the true circle which the tread of these wheels exhibited, six of the latter being tested as received new from an equal number of founders.

In conducting this test the tread was divided into eight sections, each the same distance from the flange edge, and by the use of a specially constructed micrometer any variation in roundness became apparent. In the diagram the dotted circle within the full line represents the smallest radius obtained by these measurements, and is considered as the datum line. In plotting the diagram the actual variations from the datum line have been exaggerated in the ratio of 5 to 1, to more clearly portray the irregular contour of the tread, but in every case the figures given at the eight points on each wheel represent the actual measurement. It will be noted that wheel No. 5 exhibits a departure at one point of .058 in. from the true circle, and is extremely irregular in general outline. Wheel No. 1 is badly deformed as a whole, but particular attention is invited to its contour in the vicinity of point O.

This depression, which is here so clearly indicated, may afford a solution to the vexatious problem of accounting for the presence of a mysterious flat wheel, after very light service, and when none of the usual contributing causes could be satisfactorily assigned. The same also applies in the instance of Fig. 4, in which, while the deformation is not so prominent, it is, nevertheless, clearly in evidence between points .019 in. and .026 in; in fact, all of the wheels represented in the diagram are worthy of careful study, not to mention the interesting field for speculation afforded in the consideration of what bearing the irregularity may have on the life of the wheel.

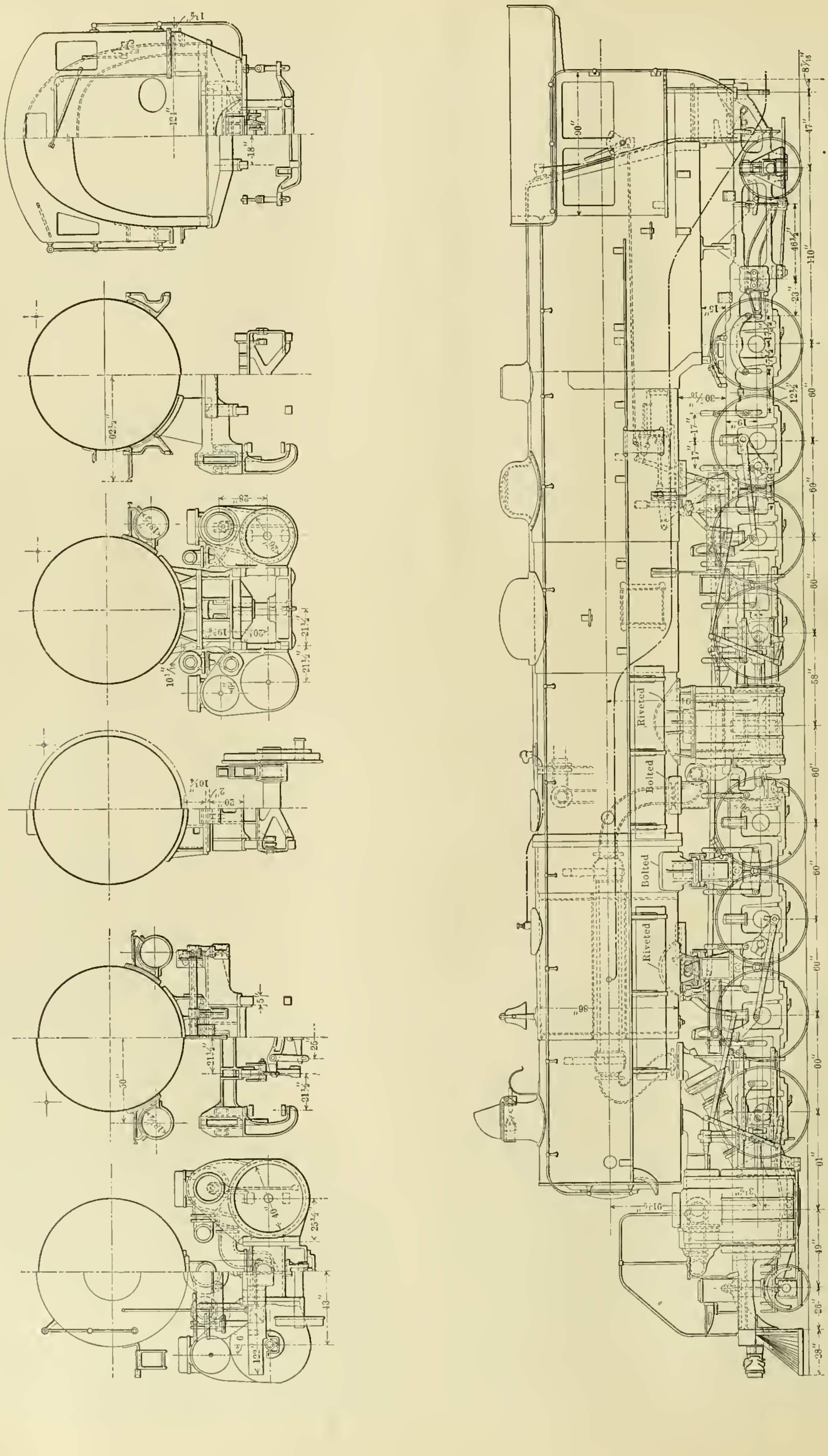
The tests effectually demonstrated the necessity for improvement in the roundness of car wheels, and it is believed that if generally applied by railroads it would result in the failure of many wheels to pass satisfactorily. The lack of roundness prevents smooth running and must cause vibration or pounding which greatly adds to the liability of rail fractures.

Reverting to Mr. West's paper, he mentions that he has conducted many experiments with his own method to secure a uniform chill, the results of which demonstrated the urgent need of having the chilled crust uniformly "hugged" during its contraction. This being accomplished disposes of the chilled proposition and at the same time should insure truly round wheels, as irregularity in contour can readily be identified with variations in the depth of the chill.

JOINT CAR INSPECTORS' ASSOCIATION.

The Chief Joint Car Inspectors and Foremen's Association held its annual meeting at Washington, D. C., last wonth. The election of officers for the ensuing year resulted as folows: Henry Boutet, Cincinnati, president (re-elected); F. W. Trapnell, Kansas City, vice-president (re-elected); Stephen Skidmore, Cincinnati, secretary and treasurer (re-elkcted); T. J. O'Donnell, of Buffalo; F. C. Shultz, of Chicago; Wiliam McMunn, of New York; L. J. Stark, of Columbus, and A. Berg, of Erie, executive committee.

THE GREAT WESTERN RAILWAY COMPANY of England, following the action of the Great Northern, Midland and Great Eastern Railway Companies, has abolished its second-class carriages and improved the third to equal the former second class.



GENERAL ELEVATION AND SECTIONS OF MALLET TYPE LOCOMOTIVE FOR THE VIRGINIAN. BUILT FOR SERVICE ON A 2 PER CENT. GRADE. TOTAL WEIGHT 448,750 LBS. TRACTIVE EFFORT 97,200 LBS.

Mallet Articulated Compound Locomotive of the 2-8-8-2 Type

A LOCOMOTIVE RECENTLY DELIVERED TO THE VIRGINIAN RAILWAY BY THE BALDWIN LOCOMOTIVE WORKS, BUILT UNDER A GUARANTEE TO HAUL 20 CARS WEIGHING 28 TONS EACH, TOGETHER WITH A CABOOSE, UP A 2.07 PER CENT. GRADE.

Exceeded in total weight by only one locomotive on our records, viz., the Santa Fe 2-8-8-2 type,* locomotive, No. 600, recently built by the Baldwin Works for the Virginian, ranks among the largest and most powerful in the world. Because of the employment of trucks, however, the weight on drivers of this locomotive is exceeded by both the Erie 0-8-8-0 type† and the Delaware & Hudson 0-8-8-0 type,‡ built by the American Locomotive Company, which weigh 410,000 lbs., and 445,000 lbs., respectively, as compared with 405,400 for the Virginian. The Santa Fe engine, with 412,350 lbs. on drivers, also exceeds it in this respect.

In general, this locomotive follows the standard practice of the builders for this class of power and contains no features of importance that have not already been fully illustrated in these columns. It is in many ways a slightly enlarged example of the two locomotives built last year by the same works for the Southern Pacific Co., which were illustrated on page 181 of the May, 1909, issue of this journal, the details being shown on page 367 of the September issue of the same year.

The evaporative section of the boiler contains 401-2¼ in. flues 21 ft. in length, which terminate in a combustion chamber ahead of which there is a feed water heater having 401-2¼ in. flues 7 ft. long. The boiler is separable as is now the standard practice of this company for locomotives of this kind, the joint coming at the middle of the combustion chamber. Instead of the high pressure steam pipe being carried outside of the boiler shell, the dome in this case is set in about its usual location for a consolidation locomotive and contains a throttle and dry pipe of the usual type, the latter terminating in a T head in the combustion chamber, from which the steam is carried in two steam pipes to a cast iron saddle secured on the under side of the combustion chamber, which has cored in it passages for both the high pressure steam and the exhaust from the high pressure cylinders. Short pipe connections continue these passages to the cylinders.

A reheater of the same type employed on the C. B. & Q. locomotive§ consisting of two large cast steel headers connected by 31-2 in. tubes, all being contained in a large 21 in. tube through the center of the feed water heater, is connected to the exhaust passage in the casting just mentioned by an elbow pipe of large radius. In the front end a pipe, shaped as shown, carries the steam to the bottom of the smoke box, where a flexible pipe continues the passage to the low pressure cylinders. These cylinders are bolted to a large steel casting constituting part of the front frame system in the same manner employed in the other design mentioned.

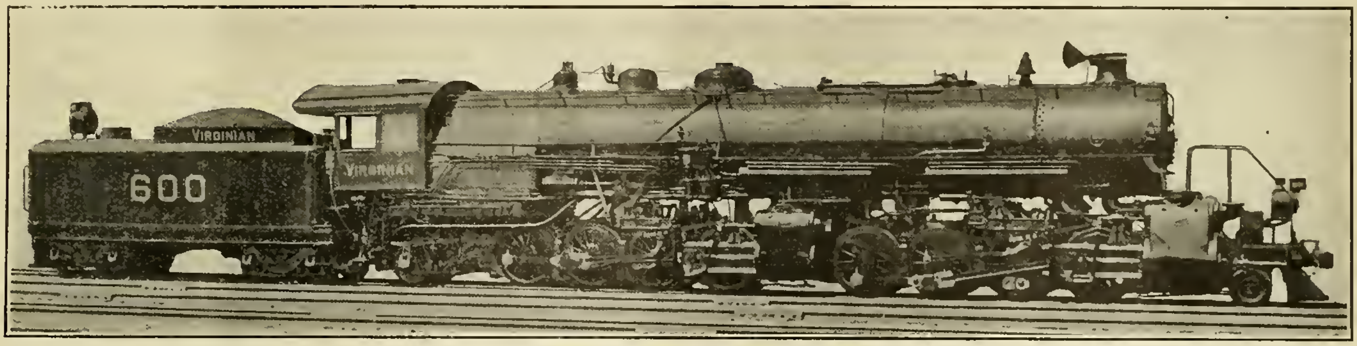
A radial stayed firebox, which approximates the Wooten type in shape and gives a grate area of 84 sq. ft., is employed. Flexible staybolts to the number of 440 are used in the throat, back head and side water legs of the fire box. The grates are arranged to rock in four sections, the dump grates being in the center of each side.

Cast steel frames 5 in. in width are used throughout. The trailing truck is of the Hodges type, a duplicate of the ones applied to the 2-8-2 type locomotives* in service on the same road.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	97,200 lbs.
Weight in working order	448,750 lbs.
Weight on drivers	405,400 lbs.
Weight on leading truck	21,000 lbs.
Weight on trailing truck	22,350 lbs.
Weight of engine and tender in working order	625,000 lbs.
Wheel base, rigid	15 ft.
Wheel base, total	58 ft. 2 in.
Wheel base, engine and tender	89 ft. 2⅛ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.16
Total weight ÷ tractive effort	4.60
Tractive effort × diam. drivers ÷ heating surface*	785.00
Total heating surface* ÷ grate area	82.50
Weight on drivers ÷ total heating surface*	58.40
Total weight ÷ total heating surface*	64.70
Volume equiv. simple cylinders, cu. ft	29.30
Total heating surface* ÷ vol. cylinders	236.00
Grate area ÷ vol. cylinders	2.87
CYLINDERS.	
Kind	Compound
Diameter and stroke	26 & 40 x 32 in.
VALVES.	
Kind	Piston
Diameter	15 in.
WHEELS.	
Driving, diameter over tires	56 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10½ x 12 in.
Front truck wheels, diameter	28 in.
Front truck, journals	5½ x 10 in.
Trailing truck wheels, diameter	36 in.
Trailing truck, journals	6 x 11 in.
BOILER.	
Style	Straight
Working pressure	210 lbs.
Outside diameter of first ring	86 in.
Firebox, length and width	126 1/16 x 96 in.
Firebox plates, thickness	⅜ & 9/16 in.
Firebox, water space	F 6 in., S. & B. 5 in.
Tubes, number and outside diameter	401—2¼ in.
Tubes, length	21 ft.
Tubes, feedwater heater	401—2¼ in. 7 ft. long
Heating surface, tubes	4,934 sq. ft.
Heating surface, firebox	298 sq. ft.
Heating surface, total boiler	5,232 sq. ft.
Feedwater heater heating surface	1,694 sq. ft.
Grate area	84 sq. ft.
TENDER.	
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,500 gals.
Coal capacity	16 tons

*Includes feed water heating surface.



2-8-8-2 TYPE LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE VIRGINIAN RAILROAD.

* See AMERICAN ENGINEER, December, 1909, page 477.
† See AMERICAN ENGINEER, September, 1907, page 338.
‡ See AMERICAN ENGINEER, June, 1910, page 207.
§ See AMERICAN ENGINEER, May, 1910, page 171.

* See AMERICAN ENGINEER, June, 1909, page 225.

The Pioneer in Introducing General Piece-Work

A REVIEW OF THE BALTIMORE & OHIO'S EXPERIMENT OF TWO DECADES PAST, IN WHICH EVERY OPERATION IN THE MECHANICAL DEPARTMENT OF THE RAILROAD HAD ITS PRICE.

Twenty years ago, or, to be exact, on November 15, 1890, an important conference was called at the Mt. Clare shops of the Baltimore and Ohio Railroad, in Baltimore, Md. In view of the importance which attaches at the present to piece and bonus work, it is interesting to recall that the discussion which the above gathering implied had for its end the inauguration of a piece-work system on a scheme so comprehensive as to be practically undreamed of in a period where compensation for labor in other than the straight day basis was universally viewed with distrust.

It was proposed in this meeting that every operation connected with the building and up-keep of cars and locomotives should

46.

VALVE SEATS. Facing---All classes.

Disconnecting tallow pipe	.02
Removing steam chest top casing	.02
Removing steam chest side casing	.02
Removing steam chest cover	.16
Removing steam chest studs, per stud	.01
Disconnecting valve stem from yoke	.02
Removing steam chest relief valve (if necessary)	.02
Removing steam chest	.05
Facing seat and spotting valve, by hand	1.25
Facing seat and spotting valve, by rotary planer	1.00
Applying steam chest	.05
Applying steam chest studs, per stud	.01
Applying side casing	.02
Applying steam chest cover	.16
Applying top casing	.02
Connecting tallow pipe	.02
Connecting valve stem to yoke	.02
Applying steam chest relief valve (if removed)	.02

In instances as above where seats are faced opportunity should be taken to secure new port marks on valve stem---------.25

It is preferable in removing the steam chest to lift the chest and valve yoke off the valve, allowing the latter to remain on the seat, this to avoid breaking the valve stem metallic packing. In construction which does not permit this,

removing packing and valve yoke	.10
Applying metallic packing and valve yoke	.10

VALVE SETTING. All classes.

It is presumed that the port marks are on the stems; if not the local piece-work inspector will allow from the above operations in connection with facing valve seats payment for the parts necessarily removed and re-applied; these would be, disconnecting and connecting tallow pipe; removing and applying top casing, and removing and applying top of steam chest, or cover. The valve setting operations then follow as below: the locomotive being moved under its own steam.

Getting centres, per centre	.18
Tramming valve stems, per side	.15
Changing eccentric rods having liners in foot, each	.16
Removing and re-applying non-adjustable rods, each operation	.20
Changing lead, per eccentric	.30

These are the common operations in roundhouse valve setting. If necessary to go further into it be governed by erecting shop book prices for removing and applying reverse lever, quadrant, reach rod, lifting shaft, link hangers, links, rockers, rocker boxes, and valve stems.

FIG. I

be paid for on a price per job, no matter how insignificant or how elaborate the work might be. It was a daring conception in those days, when the day or the hourly rate absolutely ruled, because it meant the retirement of a plan of pay for labor which for generations had been handed from father to son, and furthermore it was in connection with the oldest railroad in America: one on which drastic innovations were practically unknown, and one which was ever characterized by adherents to time-honored standards.

Those who attended were A. J. Cromwell and William Harrison, respectively superintendent of motive power east and west of the Ohio River; S. B. Crawford, master mechanic of the Mt. Clare shops; I. N. Kalbaugh, master mechanic of the Pittsburg shops; E. L. Weisgarber, from Newark, O., and many others who have since helped to make B. & O. history. It was the aim of these men, through instructions from Charles F. Mayer, then president, to evolve a scheme of piece work which would absolutely preclude day or hourly work, in other words, a scheme so complete in its detail that if a man picked some broken cylinder packing rings from the roundhouse floor and threw them in the scrap bin, a price would be set on the operation. This may seem preposterous almost, but it is nevertheless the refinement in which it was intended that it should be worked.

Before proceeding with a review of what was adopted, and what was accomplished, it may be well to glance at that period from a labor standpoint, in order to determine whether acquiescence or opposition was the attitude of the rank and file: those naturally most affected through the innovation. It may as well be said, having voluntarily espoused this consideration, that in those days organized labor, so far as applied to shopmen, was an inconsiderable reckoning. While it is very true that certain organizations existed, there was no unity of purpose, no agreements signed by the party of the first and that of the second part, and a full realization on the part of labor that it would come out second best in any protracted struggle effectually forbade any resistance to a mandate of the railroad company.

Had organized labor existed at the time in its present strength it is quite likely that it would have resisted and defeated piece-work. As it was, there was a violent opposition to the new plan in evidence, and although conference succeeded conference, it did not get under way in the elaborate form proposed until 1893, when times were so bad that some shops worked only eight hours per day, three days a week.

The Baltimore and Ohio in those times was not the splendidly developed and smooth working property of to-day, but it was still a road of considerable importance, and properly ranked as one of the great trunk lines. It maintained large locomotive and car repair shops at Baltimore, Md.; Martinsburg, W. Va., and also at Keyser, Piedmont and Grafton in the latter state; Pittsburgh, Pa.; Newark, O., and Garrett, Ind. In addition to these principal division points there was a large number of small outlying terminals scattered over the road from Chicago to Philadelphia. The system generally was not in good condition; in fact, even in 1893, the handwriting on the wall which pointed to the receivership which followed in 1896 was plainly visible. It is believed that the general piece-work system was the last desperate stand to forestall the inevitable.

In brief, the plan evolved after long deliberation was that of straight piece-work; that is, a price for each and every job, and with no guarantee of a man's pay at his regular day rate. The average pay for a machinist on the Baltimore and Ohio in 1893 was $2 per day, or probably the average was slightly lower, say $1.95; boilermakers, about $2; carpenters, painters and pipe fitters, $1.75, rates but little more than half what is now paid for similar trades.

It was the scope of the scheme to pay only what was earned; for instance, if a man was unfortunate, and only made a dollar, he was a dollar in the hole on his day's pay; if things worked well and he earned three dollars, he was one ahead, which might help to make up for a bad day to-morrow. There was bitter dissatisfaction expressed over this plan, because on some of the jobs it was impossible to come out, and it should be remembered, in connection with roundhouse work, that every mechanic had a helper at $1.25, thus forcing the mechanic to earn $3.25 to quit even on the day.

In the machine shops, where the work was continuous, it worked well enough, and in the erecting shop, when the work was furnished with reasonable promptness, there was little complaint, but in the roundhouse, where work is impossible to foresee, it became a distressing proposition. A mechanic with his

OFFICE OF THE GEN'L SUPT. OF MOTIVE POWER.

Mt. Clare May 27 1894

Mr. John Brown M. M.
Garrett, Ind.

We note that the price paid in your shops for removing old and applying driving spring, Class I-6 Eng. is $1.50 while the price paid at Philadelphia for the same operation is .75. Please advise what difference in conditions exists in your territory making it necessary to warrant an increase of .75 over the price paid in Phila. In your reply use ruled space below, which do not detach from this form.

Yours truly,
W. A. Smith
General Piece Work Inspector.

Reply to above: Garrett, Ind. June 2 1894
Before piece work was started the day rate for machinists was higher west of the Ohio river than in the east, therefore this was the lowest piece price at which we could consistently arrive and be fair to the men.

John Brown M. M.

FIG. 2.

helper might be out of a job for two hours, thus losing between them 65 cents, because this system of piece work did not make provision to pay men for waiting on work. If a main rod brass had to go to the machine shop to be rebored, there was nothing for the roundhouse mechanic and his helper to do but stand around at their own expense until it was ready, unless the harassed foreman could find them a little job on some other engine in the meantime. Every conceivable and imaginable job was covered in the piece-work schedules, the preparation of which required over two years, and the master mechanics had no authority whatever to revert to day work, no matter what difficulties the operation might present, or how much money the man doing it was losing. It was to be piece-work absolutely, from one end of the railroad to the other.

During the two years mentioned all of the various operations in the different shops were prepared on standard typewritten sheets, and from these blue print books were made, with a white marginal line to the right for the insertion of the price to be paid. A set of these books, each covering its particular department, was then forwarded to the various master mechanics, who were privileged to set their own price against the operation, presumably without knowledge of what was being paid on any of the other divisions. Fig. 1 is a reproduction of one sheet from the running repair book, and is interesting as an illustration of the detail followed out, and incidentally the money paid in those days. It, however, should be recalled that, in 1893, 18 x 24 in. engines ruled, and the parts were light and easily handled.

After setting the prices each master mechanic returned his set of books to the General Piece Work Inspector at the Mt. Clare shops in Baltimore, where they were entered on large charts for comparison. It is proper to explain at this point that no prices were set by the officials in Baltimore. This was a matter for the division master mechanics to handle exclusively, but the value of a comparison between all divisions of the prices set on a single operation is obvious.

In the majority of cases there was a striking uniformity in the prices assigned, while in others great discrepancies were in evidence, of which the following may serve as an example. An eastern shop of the system, which we will call Philadelphia, entered in its running repair book a price of 75 cents for removing a broken spring and applying another to a certain class of engine, while a western shop, called Garrett, returned a price of $1.50 for the same operation. This was an instance of extreme variation in rates, and all such were handled by the general piece work inspector on forms illustrated in Figs. 2 and 3, which are largely self-explanatory.

That great good was achieved through the proper use of these forms is clearly indicated by an analysis of the forms. In this case a competent general piece work inspector would immediately familiarize himself with the operation in Philadelphia, through which the price was so greatly reduced in connection with the application of this spring, and would hasten to communicate this particular method to the remaining shops on the system, with the ensuing good result that the price would inevitably become harmonized throughout the length of the railroad.

To further explain, it will be seen that the master mechanic at Garrett was not in possession of the most practical method to remove the spring in question. He took refuge behind the fact that labor is more highly compensated west of the Ohio River than east of it; as it also applies to west and east of the Mississippi, but the use of the two forms as herein illustrated brought out the truth, that the master mechanic in Philadelphia had found a way to pull this spring out without dismantling foreign parts of the locomotive, and in consequence could assign a greatly reduced price and still allow the mechanic to make a small profit.

This is only an illustration of what prevailed in many other roundhouse operations, and shows clearly that the various shops of the road were in absolute ignorance of the methods of their neighbors. So, even if this system of piece-work failed, or was eventually abandoned, it certainly served a useful purpose in standardizing shop methods.

Despite its crudities, the system endured for at least three

OFFICE OF THE GEN'L SUPT. OF MOTIVE POWER.

Mt. Clare May 27 1894

Mr. G. Jones. M. M.
Philadelphia Pa

We note that the price paid in your shops for removing old and applying driving spring Class I-6 Eng. is .75 while the price paid at Garrett for the same operation is $1.50. Please advise how you are able to perform this operation at a rate so much lower than that paid at Garrett which in this instance is .75. In your reply use ruled space below, which do not detach from this form.

Yours truly,
W. A. Smith
General Piece Work Inspector.

Reply to above: Philadelphia Pa. 6/1 1894
When these engines first came here we discovered a way to remove and apply these springs without taking down a portion of the brake-rigging which I understand is being done elsewhere; hence our lower price.

Geo. Jones M.M.

FIG. 3.

years. Without a doubt the railroad company had the best of the bargain, because a careful analysis of a single machinist's time for two years under this piece work, compared with the same period under day work, showed an increase in the number of individual operations performed of 65 per cent., with a grand average of an increase in pay of but 5 per cent. The prices were so low that even with the minimum day rate prevailing at the period it required vigorous effort to come out even on the day. If a machinist's or a boilermaker's pay averaged $57 per month on day work, and this represents about the average for the times, it seldom rose above $65 on the piece work basis, and no comment need be made on the superior effort set forth under the latter plan.

Before dismissing this matter it is of interest to recall that the plan did embody a successful application of piece-work to locomotive running repairs; that is, a more successful application than is evinced in even these latter days, in which the roundhouse end of it has always proved the snag in straight piece-work. Maybe after all it worked, because from what was said at the beginning, the railroad had all the best of it in the labor situation. There was no concerted effort to resist it, because the times were hard; there was no organization, and in the end the men would have been badly worsted.

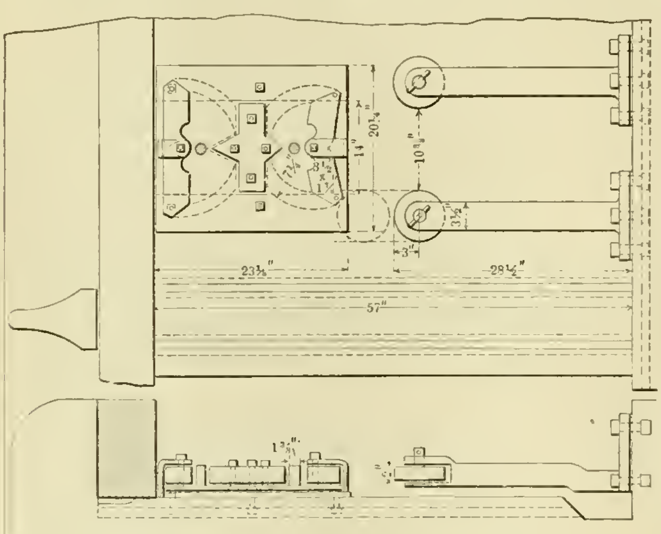
In the principal divisional points no hardship was entailed on anyone, as the work was coming all the time, and very few instances can be recalled where a man quit the month any worse off than if the day rate had been followed throughout, but in the smaller places the scheme was impracticable, and should never have been installed. At Wilmington, Del., for instance, which at that time was probably run on a smaller scale than any outlying point on the Baltimore and Ohio, the wages of some car repairers were pathetic. The figures are not at hand, but if memory serves, a repair man at $1.40 daily rate was fortunate to draw $1.

Nevertheless, the plan was assiduously pushed until the crash came in February, 1896, when the road passed into the hands of John K. Cowan and Oscar G. Murray, receivers. G. B. Hazlehurst was succeeded shortly after that time by J. Harvey Middleton, as general superintendent of motive power, and one of the first moves of the new mechanical department management was to practically abolish the piece-work system. Whatever piece-work conducted after that was left entirely to the discretion of the various master mechanics. The shop men returned to the day rates which they held previous to 1893 and 1894, and quite a period elapsed before any further consideration was given to the subject.

BENDING BRAKE SHAFT BRACES

Brake shaft braces come within the class of work which is well suited for manufacture with a bulldozer, and at the Readville shops of the New York, New Haven & Hartford Railroad, a set of dies have been evolved for performing that operation, so that these braces are turned out at the rate of about 100 per hour, two men being required.

The dies and their arrangement, as well as the brace before and after bending, are shown in the illustration. Dies for two different sizes of braces are included on the same base, and



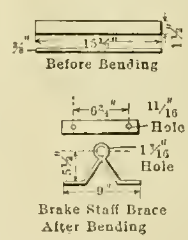
FORMERS FOR BENDING BRAKE SHAFT BRACES.

either one can be used. They consist, as will be seen, of a pin of the right diameter, back of which are hinged two swinging formers, which close down upon a stationary form in such a way as to force the ⅜ by 1½ inch bar around the pin, and in one operation form it to the proper shape. The swinging dies are forced inward by rollers carried by extending arms located the proper distance apart and secured to the movable head of the bulldozer.

After the braces have been formed, the holes are punched cold in an ordinary punch, a gauge being used which eliminates the necessity for any marking.

MILEAGE OF MEXICAN RAILWAYS.—In a message to the Mexican Congress, President Diaz reviews the progress of the railroads of Mexico during the last six months as follows: "The additions to the railways under federal jurisdiction since April last have been 148 miles, and those railways now aggregate 12,225 miles, so that the 3,000 miles of railways subject to the jurisdiction of the state be added, we obtain a total of 15,225 miles as the present length of railways of the Republic.

PROPOSED IMPROVEMENTS ON THE BOSTON AND MAINE.—President Charles S. Mellen, of the New York, New Haven and Hartford Railroad, and lately elected president of the Boston and Maine, will take the full duties of the presidency in solving the important problems in improving the latter system. An important branch of those problems is the relaying of a large part of the system with new rails, the purchase of new equipment, and particularly of heavier locomotives for service upon the northern part of the system, and the Fitchburg line. Another important improvement proposed is the electrification of service through the Hoosac tunnel. This will require several years to complete. The $10,000,000 lately voted by the directors will be used for these improvements, and is in addition to a large sum expended during the past year.



STEAM RAILROAD ELECTRIFICATION IN GERMANY.—The experiments which have been carried on in Germany during the last three years with a view to replacing steam by electric energy on the lines of railway have been so conclusive that it has been resolved to introduce the new method of traction at an early date on several lines of railway. Before the end of the present year the work of electrifying the railway running between Bitterfeld and Dessau, the first section of the railway connecting Madgeburg, Leipzig and Halle, will be finished, and during 1911 the work will be begun on the line connecting Dittersbach and Lauban in Silesia. This latter line runs through very mountainous regions.

ALTERNATING CURRENT FOR HEAVY TRACTION ABROAD.—Glancing over a list of the twelve or fifteen three-phase roads and the twenty-five or thirty single-phase roads in Europe, I find that there was much that I did not see, but what I did see was impressive of present progress and of the large plans which are being made for the future. Practically all interest seems to be directed toward alternating-current development for heavy traction, either single-phase or three-phase, and at a low frequency, approximately fifteen cycles, this being accepted as the standard by several governments.—*Chas. F. Scott in the Electric Journal, October.*

The Acetylene Welding Torch

A DISCUSSION ON THE MIXING OF GASES IN THE TIP OF A WELDING TORCH, HOW THE HIGH TEMPERATURE IS MAINTAINED AND WHY IT IS NECESSARY. HOW THE DANGER OF EXPLOSION HAS BEEN ELIMINATED AND THE METHOD OF USING THE TORCH ARE ALSO CONSIDERED.

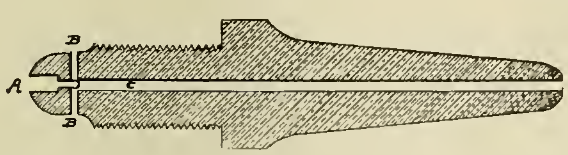
J. F. Springer.

While there are a number of methods for obtaining high temperatures, the most familiar is probably that of combustion. Ordinary combustion consists in the chemical union of oxygen with some other substance, and by this process heat is evolved. Thus, when coke combines with oxygen to form the poisonous gas, carbon monoxide (CO), a considerable amount of heat is set free. If hydrogen gas is burnt, that is, combined with oxygen, we get a large amount of heat. Heat can also be obtained by breaking up, or exploding, certain compound substances. Thus, when nitroglycerin is exploded, heat is evolved. The former method is in use everywhere, but the latter is practically unknown. There is a third source of heat; viz., the electric current. When a strong current is made to pass through a wire whose diameter is such that there is inadequate provision for conduction, then we get heat from the resistance of the wire, and this is what takes place in the incandescent electric bulb.

In the oxy-acetylene torch heat is secured through a combination of the first two methods. First, there is a detonation of the acetylene as it emerges from the nozzle; and, second, by the carbon gas resulting from this breaking up of the acetylene combines with the oxygen flowing out of the tip. About one-half of the resulting heat is supplied by each chemical action, but this double source of heat is not sufficient to account for the very high temperature obtained. It is said that the oxy-acetylene torch of the Davis-Bournonville Co., 90 West Street, New York City, is capable of producing a temperature of 6000° F. or more. It so happens that about twice as much heat is produced in the outer, or enveloping flame, as in the inner, or working, flame. The advantage of the inner flame lies in the concentration of heat. In an ordinary torch this little inner flame will be, perhaps, half an inch long, and have a diameter of about one-sixth of an inch. Here is concentrated about one-third of the total heat produced by the detonation and total combustion of the acetylene.

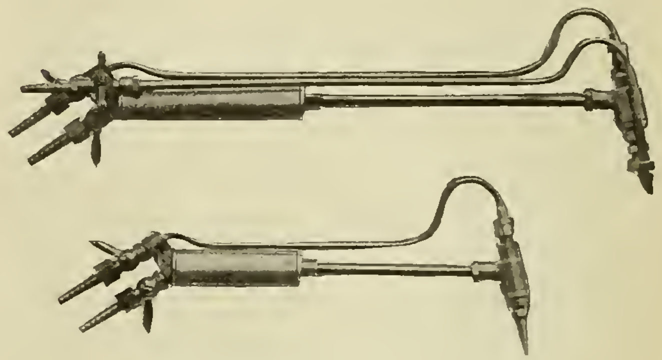
It is of interest to know why the little inner flame which does the work is so bright. Apparently, the reason is that here the carbon is flowing along uncombined with anything, but at a very high temperature. It has just parted from the hydrogen, with which it was combined when in the acetylene, and flowing along at a high temperature, it shines with a bright white light.

Surrounding the little working flame is a large enveloping



SECTION OF THE WELDING TIP

flame. This is hot, but not hot in comparison with the smaller one. Here, no doubt, the poisonous carbon monoxide is burnt to the dioxide. The danger of carbon dioxide to life is because it may, under favorable circumstances, prevent sufficient oxygen reaching the lungs. It smothers but does not poison, so the large flame may be regarded as advantageous, because it converts a deleterious gas into a non-deleterious one. The hydrogen that comes through from the little flame burns to water vapor here in the large one. In fact, the combustions going on produce a large supply of heat, though not a high temperature, which is accounted for by the fact that the heat is scattered over so much space. The large amount of heat, however, is of service in protecting the little working flame from loss of its heat through radiation and the like, and, further, there is probably some free oxygen coming through the little flame. The reason for this statement is that it has been found necessary to supply more oxygen in mixing than is really required to burn the acetylene to carbon monoxide, which necessity is probably due to difficulty of getting perfect mixture, the remedy being to supply an excess. The oxygen coming through the little flame would,



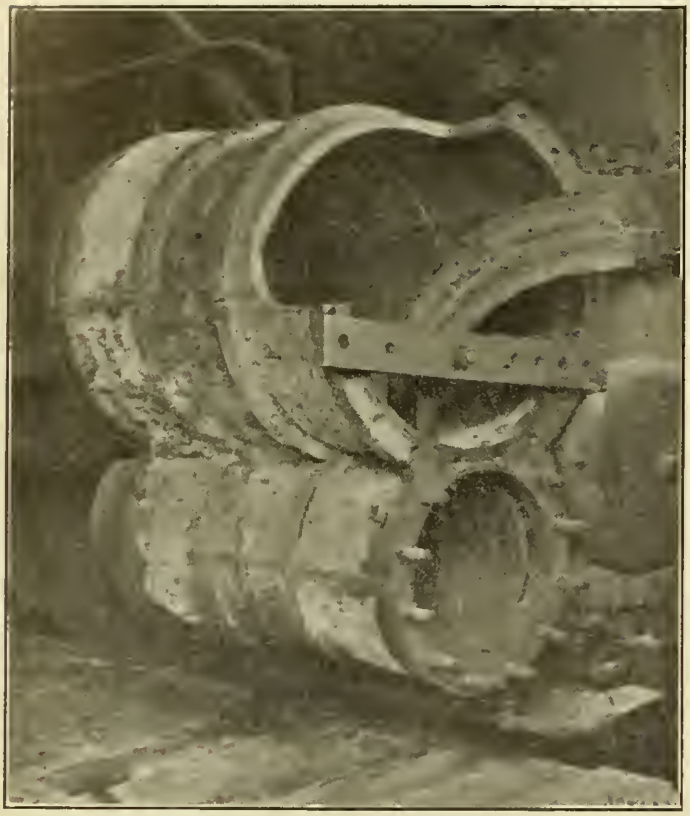
TWO SIZES AND DESIGNS OF WELDING TORCHES

if not consumed in some way, oxidize the work, which might prove serious and even prohibitive. It is, no doubt, the enveloping flame which takes care of this surplus, its hydrogen and carbon monoxide sucking up the oxygen. The outer flame is, therefore, to be considered on the whole as a very valuable adjunct.

Curiosity may be entertained why it should seem important to secure temperatures of 5000° and 6000° F., but it should be remembered that this temperature is that of the flame and not of the work. It would be useless to heat the metals to any such temperature. In explanation it may be said that the oxy-acetylene torch is used in the open air to affect the heating of a small quantity of metal. The bulk of the work acts as a dissipater of heat. Consequently, because of dissipation into the atmosphere and through the body of the work, it is absolutely necessary to furnish a temperature far in excess of that required to melt the metal itself.

The nozzle used by the company mentioned is simple in form and is shown in section in one of the illustrations. Oxygen comes in along the axis under pressure, and is made to pass through a very small orifice (A). Emerging from this it still has nearly the whole length of the nozzle to traverse. However, just a little forward of the front side of the small orifice, there are several others (B) arranged in the wall of the nozzle. These admit acetylene in radial streams, which is under less pressure than the oxygen. The two gases thus meet when moving in directions at right angles to each other, and in consequence a certain amount of mixing takes place at once. Further mixing occurs as the two gases move on through the length of the nozzle. This passageway has a smooth cylindrical wall, and its length provides opportunity to complete the mixing to a more or less perfect stage. It seems important that the mixing chamber should be a plain bore without turns or obstructions to effect intermingling; otherwise danger might perhaps arise in connection with the acetylene which is an explosive gas. In this tip, oxygen under high pressure drives acetylene under low pressure along a straight and smooth bore.

In that part of the torch back of the tip, the acetylene is made to pass through a packing of asbestos and mineral wool. This protection is similar to that afforded by the gauze of the miner's lamp. The acetylene can pass, but not the flame. But, even if a flare-back should pass this packing, there is another and very reliable safeguard. The tube which leads back to the acetylene generator-and-reservoir passes into and out of a water



BROKEN CYLINDER ON A VANCLAIN COMPOUND LOCOMOTIVE. AN ATTEMPT WAS MADE TO REPAIR IT WITH THERMIT, BUT OWING TO THE MOLD SLIPPING THE PIECE BROKEN OUT WAS RUINED. A NEW PIECE TO FIT WAS THEN CAST AND WELDED INTO PLACE BY THE ACETYLENE PROCESS AS IS SHOWN BELOW. THE LOCOMOTIVE IS NOW IN SERVICE WITH NO SIGN OF A LEAK OR ANY WEAKNESS.

tank. Here it is interrupted, so that communication between the two portions of the tube is only secured by passage through the water. A flare-back would thus be extinguished before it could reach the acetylene supply. It would seem very unlikely, however, that a flare-back should occur, when the manner is recalled of the way the two gases enter the tip.

The oxygen comes in along the axis and forms the main current, because it comes in under higher pressure, and because its direction of flow is not changed in the tip. The acetylene joins this current coming in from the sides. It is under a less pressure and has its direction changed; and, further, the oxygen strikes it from behind, as it were. Apparently, the only way a flare-back could occur is for the oxygen to find its way in some manner back through the acetylene supply pipe. By avoiding the presence of any obstruction to the flow of the oxygen through the tip, all danger of this would seem to be eliminated. Perhaps, however, it would be best for workmen to avoid allowing the end of the tip to get clogged or otherwise obstructed by the work. But even so, there are two safeguards back of the tip: the packing and the water tank.

The oxy-acetylene torch is easily handled like any other tool. The great temperature of the little inner flame is employed with striking results in effecting what are called "welds." That this term is scarcely a proper one will readily be understood when the true character of the process is understood. We will suppose that we wish to join the edges of two sheets of ½-in. steel. Each edge is first beveled off at an angle of 45°, so that when the two are placed together we have a groove with an angle of 90°. The operator begins the use of the torch to heat the sides of the groove, particularly at the bottom. As the metal softens, matters are so managed as to fill in the bottom with metal from the work, and then to fill in the groove higher up by melting new metal from a rod. Attachment to the groove sides is accomplished by heating them to a more or less softened condition. In all this work the little flame is the principal agent. The filling in is continued until the whole groove is filled, and if it is desired to make the seam especially strong, the new metal can be added until a slight ridge is formed, which can be rounded off to present a neat appearance. The foregoing is the general method, and it will be seen at once that it is quite different from that employed by the blacksmith, as the metal is actually melted. At the junction of the new metal with the old the employment, at times, of a hammer or similar instrument may facilitate the union with the old. Perhaps the name *fusion welding* best covers the operation.

As already suggested, the work itself tends to carry off heat. This, of course, increases the duty of the torch. If the metal is in the form of quite thin sheets, then the torch can be depended upon to accomplish the union unaided. The loss of heat becomes so enormous, however, in cases where the metal is thick that oftentimes it is economical or necessary to assist the torch. For example, it is quite possible to unite metal where the thickness is 5 or 6 inches. The groove is prepared as usual, but in order to prevent excessive losses of heat from the little flame an additional source of heat is provided. In some cases it may be possible to maintain a charcoal fire beneath the locality of the groove. In others, the adjacent metal may be heated by any convenient means, as in a furnace, and the welding effected while the work is still hot, or a flame such as that provided by the Rockwell torch may be used in conjunction. In any case, the idea is to supply from another source a portion of the heat otherwise carried off by radiation and conduction.

A little consideration will show one that the metal involved, both new and old, is subject to very considerable expansion and contraction. Mild steel has a co-efficient of linear expansion of about 0.0000066 for 1° F. For, say 2400°, we should have 0.01584. If at the top of the groove the new metal has a width of 5 inches, the shrinkage from a molten, or nearly molten, condition would be considerable. The same thing goes on propor-

THE CYLINDER AFTER NEW PIECE WAS WELDED INTO PLACE

tionately in smaller welds, and it will be seen that the operator will have something more to do than merely fill up the groove and see that a satisfactory union between old and new metal takes place. He must manage the cooling to prevent contraction cracks, and here is where skill and experience are required.

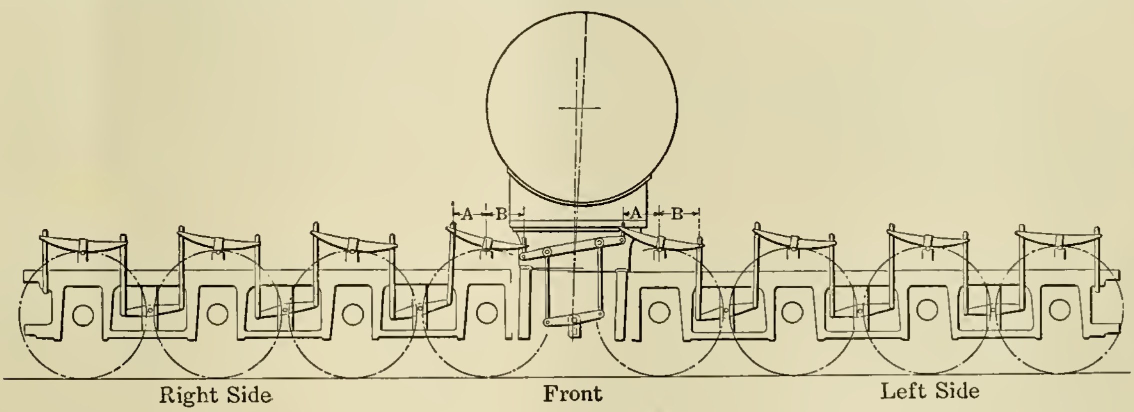
Welding by means of the oxy-acetylene flame is a matter of only a few years, and those interested in it have by no means found out all there is to know, but perseverance and intelligence have steadily advanced knowledge so that today the successful application of the process has been made to numberless lines of work. In many of these, the methods have been more or less standardized, so that definite instructions can be given, and new work is constantly being included within the bounds of well established practice.

The great temperature of the little flame is being utilized to perform an office quite different from that of welding. The torch is often used as a "putting on" tool. For example, take the case of a large gear wheel in which a tooth has been broken. To get a new gear may involve great delay—shutting down of considerable machinery, and large expense for the wheel itself—but with the oxy-acetylene torch new metal may be added and a blank tooth built up on the root of the old. This is accomplished in the same way as in ordinary "fusion welding." There, new metal is filled into the groove, and similarly, the broken tooth can be built up, layer by layer, until a mass of such form and size has been added to enable the finishing-machine operations to produce a perfect tooth. The same procedure is applicable to cases where a lug or other protuberance has been broken off from a casting. It makes no difference whether the casting be new or old, or whether the protuberance has been broken off or omitted through oversight in casting. A little consideration will show that this building up process is extremely important. Cavities may be filled up in the same way and a blow-hole, crack or similar defect may be very thoroughly eliminated. For example, the case of a 4500-pound brass casting may be cited, which, upon examination, was found to contain certain cracks necessitating that the whole be scrapped, if not corrected, but the oxy-acetylene torch successfully reclaimed it from the scrap heap. In another case, a good-sized casting was to form part of air compression machinery, and extensive machine operations had to be carried out. When an amount, said to be $300 worth, had been done, the discovery was made that a blow hole communicated with the air chamber. Here was a case where the defect would have resulted in considerable loss. But here also the new process was equal to the requirements of the occasion.

The oxy-acetylene procedure is largely indifferent to what the particular metal is. If the material is cast iron the torch will build up new parts, fill in cavities, or unite one piece to another, and the same may be said of most, if not all, of the common metals. The great temperature avaliable secures such molten and plastic conditions that new metal can be added, and new and old united. No especial welding quality is needed. In the old days, only certain materials could be welded; and the possibilities of soldering and brazing were very limited. With the oxy-acetylene torch the new metal which is added may be precisely the same as the old. Parts of cast iron can be united by the use of cast iron in the seam. The cavities in a casting of brass or other material can usually be filled in with the same metal. The parts added by the building up procedure may be of the same material as the body, and rolled or forged steel may be hardened. The new material may often be made similar to the old not merely in chemical composition, but in its condition. This is accomplished by hammering as the new metal is added.

Indeed, parts of dissimilar metal may be united; or a part of one material may be built up on a body of a different character, which is important. In this way a bronze part may be joined to a steel part, the whole becoming a unit. High carbon steel can be united to mild steel, thus permitting the hardening of one. An example in point is where a manufacturing concern makes a pipe out of sheet steel and then adds flanges of cast steel. These are joined to the pipe by oxy-acetylene welding. It may be added that the longitudinal seam is also made by the same process. Such pipes (5 to 7 inches in diameter) are put under a pressure test of 1,000 pounds to the square inch. It is said that the test is ordinarily successful when first applied.

The chief expense in oxy-acetylene welding, when the outfit has once been obtained, is for the oxygen. The expense per cubic foot of oxygen may be taken at three cents; per cubic foot of acetylene, at one cent. Now 28 per cent. more oxygen by bulk is supplied than acetylene, so that the oxygen corresponding to one cubic foot of acetylene will cost $0.0384, making the total cost of both gases $0.0484. To make a 100-foot "weld" of 1/16-in. sheet steel, 5.6 cubic feet of acetylene will be required. The expense for gas will therefore be $0.0027 per foot, and it will take about two hours for the operator to weld 100 feet. If his time is worth 30 cents per hour, the total expense for gas and labor will be $0.0087 per foot. If the sheets are one-half inch thick, then the cost will increase to about 37 cents per foot. It is probable, however, that by perfecting means of re-heating, the cost of welding the thick sheets could be much reduced. In other words, a great deal of the necessary heating could probably be done much more cheaply by the use of fuels other than oxygen and acetylene.



SPRING RIGGING OF A MALLET LOCOMOTIVE ON A CURVE.
(SEE REFERENCE ON NEXT PAGE.)

EQUALIZATION OF MALLET LOCOMOTIVES

To the Editor:

In reply to Mr. Fowler's criticism* of my article on the "Equalization of Mallet Locomotives, which appeared on page 342 of your September number, I would like to quote from a paper read before the American Society of Mechanical Engineers in New York City, in December, 1908, by C. J. Mellin, as follows:

"On the front engine, all springs on each side are equalized together with a cross equalizer between the front springs. The rear engine is equalized in the same manner, except that the cross equalizer is omitted. This makes a three-point suspension of the whole engine and prevents any excessive local stresses of a diagonal nature on an uneven road; as the front engine accommodates itself very freely to the rear engine and approximately divides the angularity between the inclination of the axles. The

* See American Engineer, October, 1910, page 402.

wheels then follow the rail comparatively freely and easily on the twisting parts, at the rising of the outer rail, on entering and leaving curves, as well as on any other unevenness of the road."

It is self-evident that the tops of the rails at ends of curves form a warped surface and that the driving springs will have to take care of the difference between this warped surface and a plane, unless the front engine is equalized across. The point which I intended to make in my article was that this difference was not enough to cause any excessive stresses and that equalizing the springs on both sides of the front engine together, to prevent these stresses, was a cure that was worse than the disease, on account of the narrowness of the triangular or three-point support.

The sketch on the preceding page shows what happened to the spring rigging on some 2-8-8-2 engines. Some of these had the springs tilted in the direction shown and some in the opposite direction, and the condition caused serious difficulty.

It should be noted that when the springs have assumed this position they tend to remain so, on account of the difference in length of the lever arms "A" and "B."

W. E. Johnston.

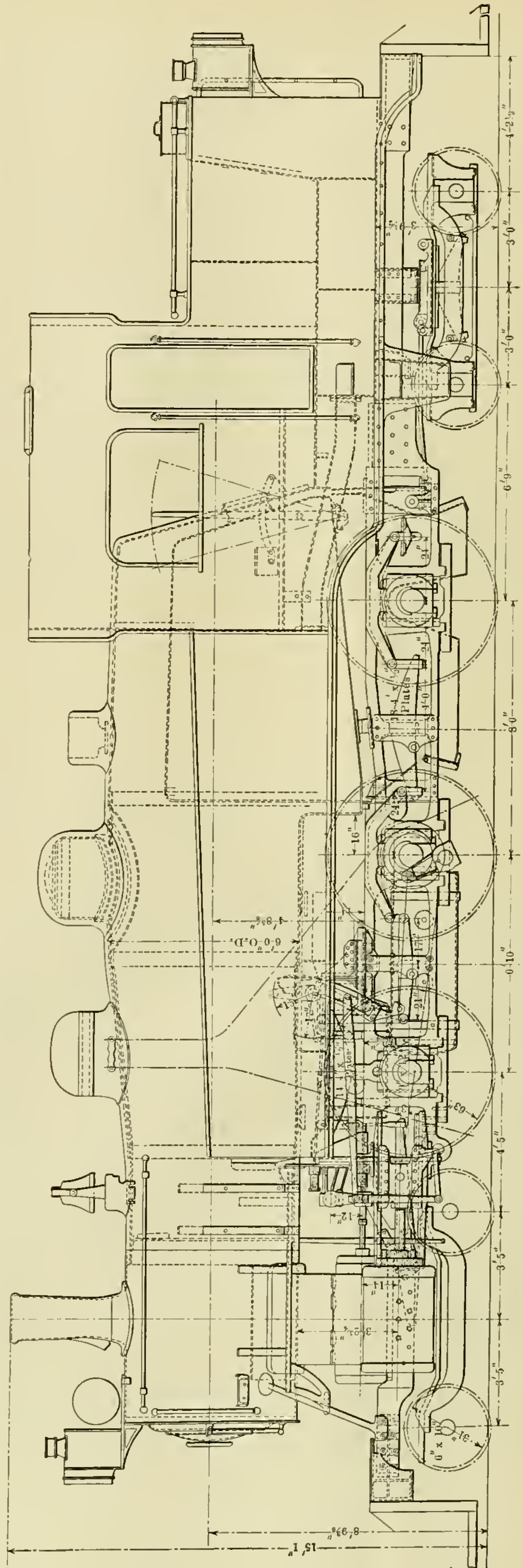
Parting of the Ways.—We take it for granted that every Traveling Engineer before he accepted the position has agreed with himself that he has come to a parting of the ways, a peaceable and self-respecting parting however, and we do not believe it possible for any one, we care not how honest he may be, to do justice to himself or any one else if he tries to look with one eye at the men and with the other one at the officials. Either one or the other of his eyes will be badly strained in the course of time and eventually both will become useless.—*From Committee Report at the Traveling Engineers' Convention.*

Success of Three-phase Locomotives in the Simplon Tunnel.—At the Simplon tunnel the trains are handled very smoothly by the Brown-Boveri three-phase locomotives. They run about forty miles per hour through the single-track tunnel, thirteen miles long with an up-grade each way to the middle. The overhead construction is simple, and in the yards outside of the tunnel the support is a light frame work of two-inch gas-pipe. Clean and agreeable as is the tunnel compared with others where steam locomotion is used, yet it is a poor substitute on a pleasant day for the beautiful trip over the Simplon Pass by the road built by Napoleon a century ago. This route, however, takes from seven o'clock in the morning until four in the afternoon instead of twenty minutes by the electric trains.—*Chas. F. Scott in the Electric Journal, October.*

Recording Steam Meter for University of Illinois.—The General Electric Company has presented the University of Illinois with a recording steam meter, a device which has been in successful use as a means of determining the quantity of steam passing any pipe to which it may be attached (See *American Engineer,* September, 1910, page 377). The gift was transmitted on behalf of the General Electric Company by its Sales Manager, F. G. Vaughan, to Professor Ernst J. Berg, in charge of the Department of Electrical Engineering. This is the second significant gift that this company has made the University during the past year, the first consisting of a 100-kilowatt Curtis steam turbo-generator which now constitutes a part of the equipment of the Department of Electrical Engineering.

Number of Locomotives Equipped with Superheaters.—Recent published reports are to the effect that there are now over 800 engines equipped with superheaters on twenty railroads in North America and the number is increasing almost daily.

Mechanical Conventions to be at Atlantic City.—At the annual meeting of the Railway Supply Manufacturers' Association, Washington, D. C., Sept. 30, it was decided to hold the next association meeting at Atlantic City, June 14 to 21, 1911, during the sessions of the M. M. & M. C. B. Associations.



Tank Locomotive for Suburban Service—Canadian Pacific Railway

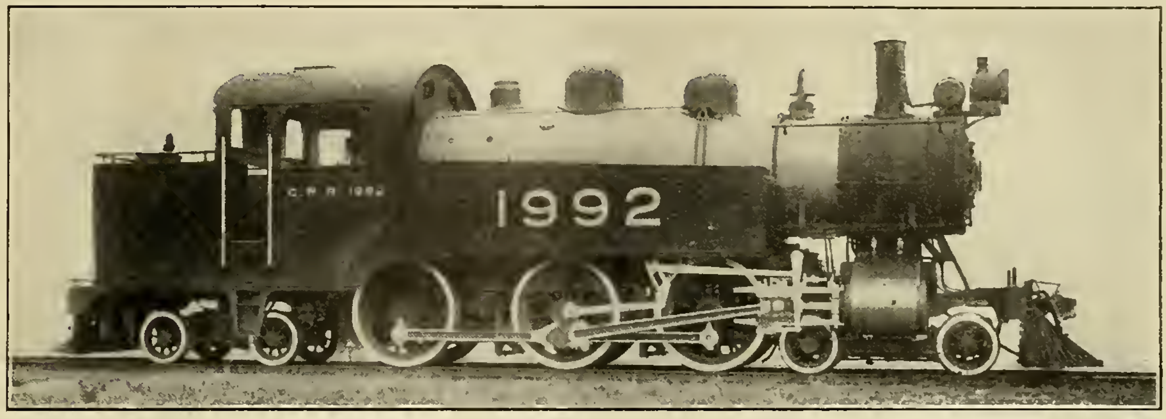
Suburban Tank Locomotive 4-6-4 Type

CANADIAN PACIFIC RAILWAY.

*An attractive appearing suburban locomotive is an unusual sight, but by careful attention to this feature the motive power department of the Canadian Pacific Railway has developed a design which in addition to amply filling the requirements of the service, presents a really attractive appearance, as is evident from the illustrations shown herewith.

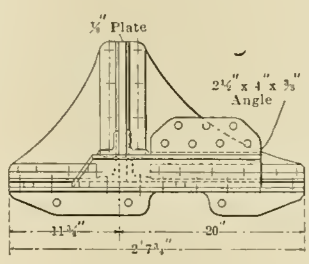
Two of these locomotives were turned out of the Angus shops some time ago and have proven to be most successful. They are designed to handle trains between the Windsor Street Station and Point Fortune, a distance of 47 miles. The average train consists of six coaches and one baggage car, and there are seven regular and thirteen flag stops west bound and four regular and twelve flag stops east bound. The schedule times are 120 and 105 minutes respectively. Coal and water is taken at Rigaud, 40 miles from Montreal. For the three months ending July 14 these two locomotives in this service made somewhat of a coal record, the consumption for that time being 345 lbs. per thousand ton miles and 79 lbs. per locomotive mile. For suburban service this is certainly a most satisfactory result.

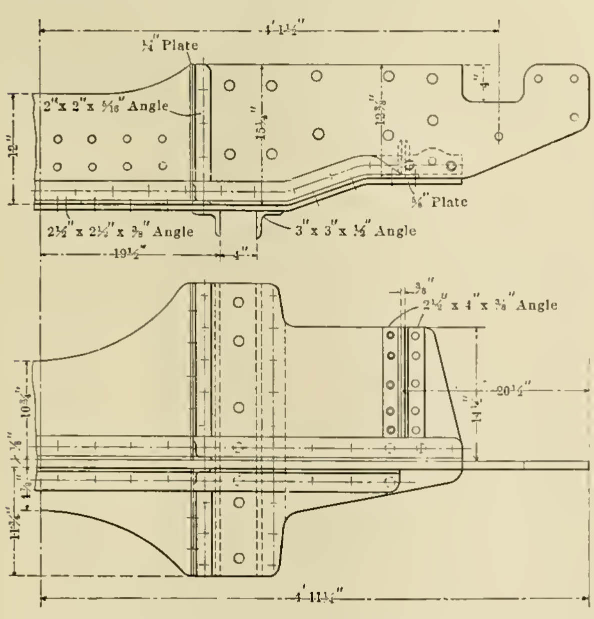
In order to obtain the capacity desired with a tank locomotive and still keep its weight within the limits of the bridges, it was necessary to give every detail of the whole design the most careful study to obtain sufficient strength with the least possible weight. This has resulted in the use of structural steel shapes and steel plates for building up many of the brackets, braces and cross ties which are usually made of cast steel. With this method it has been possible to obtain a locomotive having 20 x 26 in. cylinders; 63 in. drivers; boiler with an equivalent heating surface of 2,350 sq. ft., a tank with a capacity of 3,000 gallons of water, and space for 4 tons of coal, the total weight being but 236,000 lbs. in working order. This including, of course, about 13,000 lbs. of water and 4,000 lbs. of coal.



SUBURBAN TANK LOCOMOTIVE. DESIGNED AND BUILT BY THE CANADIAN PACIFIC RAILWAY.

A number of the parts formed of structural steel are shown in the illustrations. Among these will be noticed the link bearing cross tie, which also forms a saddle for the tanks, as well as a frame brace. This is composed of a vertical member of ⅞ in. steel plate secured to a horizontal member of ⅝ in. steel plate. There is also a horizontal stiffening plate of ¼ in. thickness and other stiffening angles and connections arranged as the illustration shows. The tanks are carried from the ⅞ in. plate by ¼ in expansion plates and are braced by ¼ in. gusset plates. This cross tie has a 31¾ in. bearing on the frames and is secured to them by 3 x 3 x ½ in. angles, one on either side of the frame.



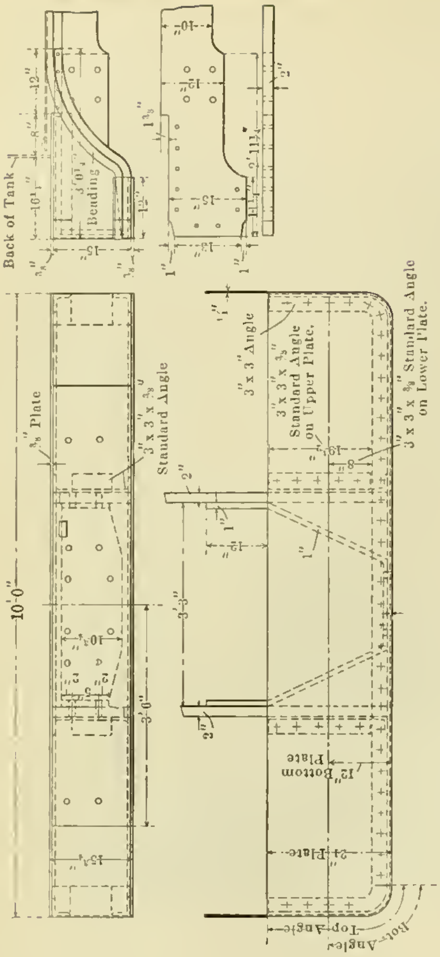


LINK BEARING CROSSTIE AND TANK SUPPORT, BUILT OF STEEL PLATES AND ANGLES.

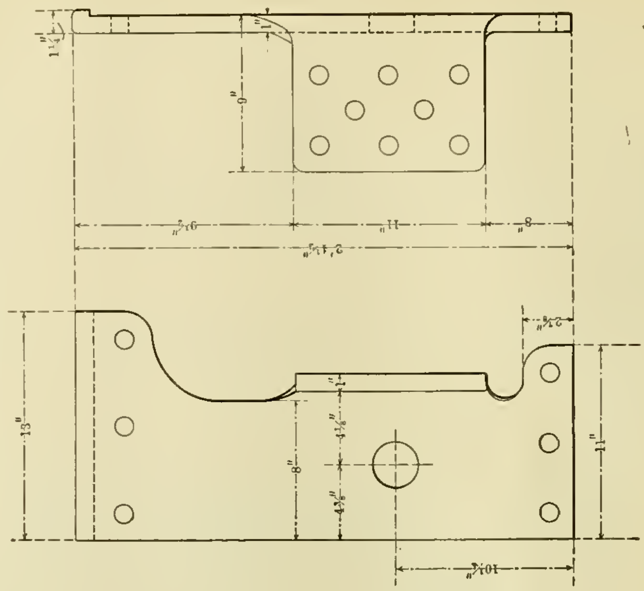
As the tanks are secured to the boiler at its front end and the whole construction of tanks and crossties are riveted and bolted together both to boiler and frames, it forms an absolutely solid support for the link; in other words, the tank has been made to reinforce the crosstie, and resists the thrust of the link.

Other structural steel details are the rear engine truck crosstie, front and back bumpers, expansion brackets, etc. The rear engine truck crosstie is composed of a ¾ in. plate, braced by two ⅜ in. plates riveted to it, a check for the frame fit on each side was obtained by machining down a 1 in. plate to form the horizontal member. The rear bumper outside the frame is made only sufficiently strong to take push pole thrusts, but between the frames, where the pilot coupler is attached, it is strongly braced by 1 in. plate. There is a 15 in. channel facing which extends out to the sides of the back tank and has ⅜ in. top and bottom cover plates which braces it strongly together.

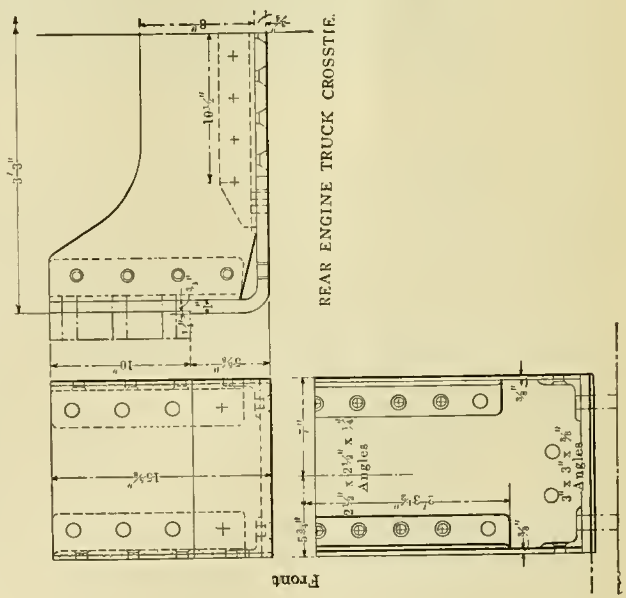
The front bumper which will have to withstand cornering



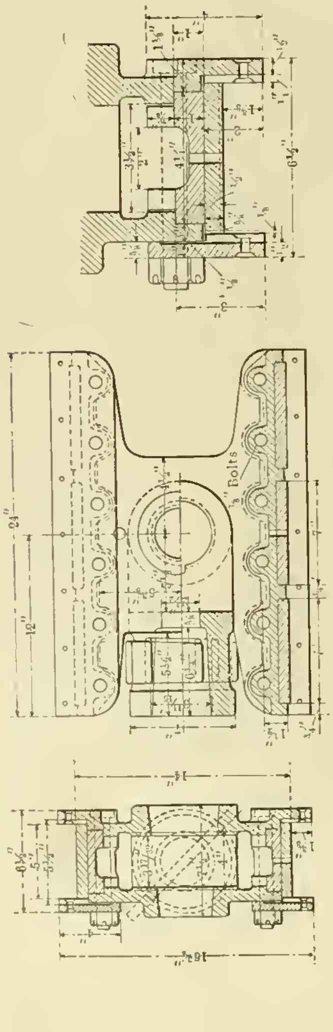
BUMPER BEAM AT BACK OF TANK. BUILT UP OF STEEL PLATES AND ANGLES.



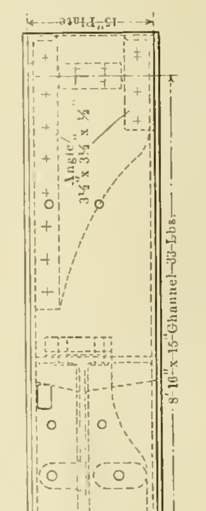
EXPANSION PLATE BRACKET.

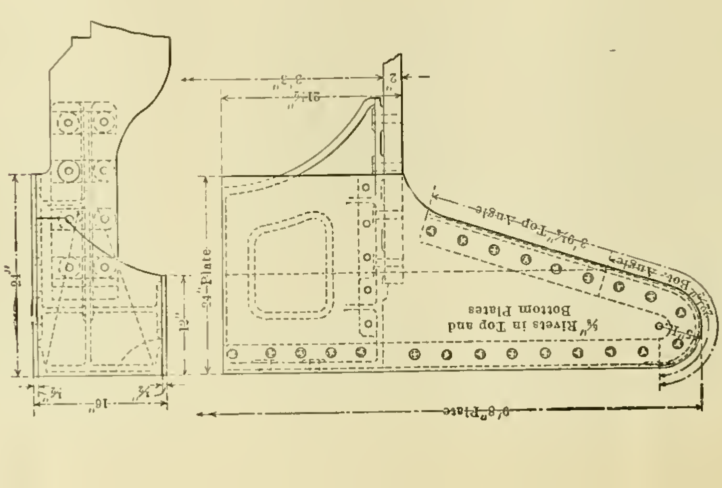


REAR ENGINE TRUCK CROSSTIE.



CROSSHEAD WITH REMOVABLE GIBS.

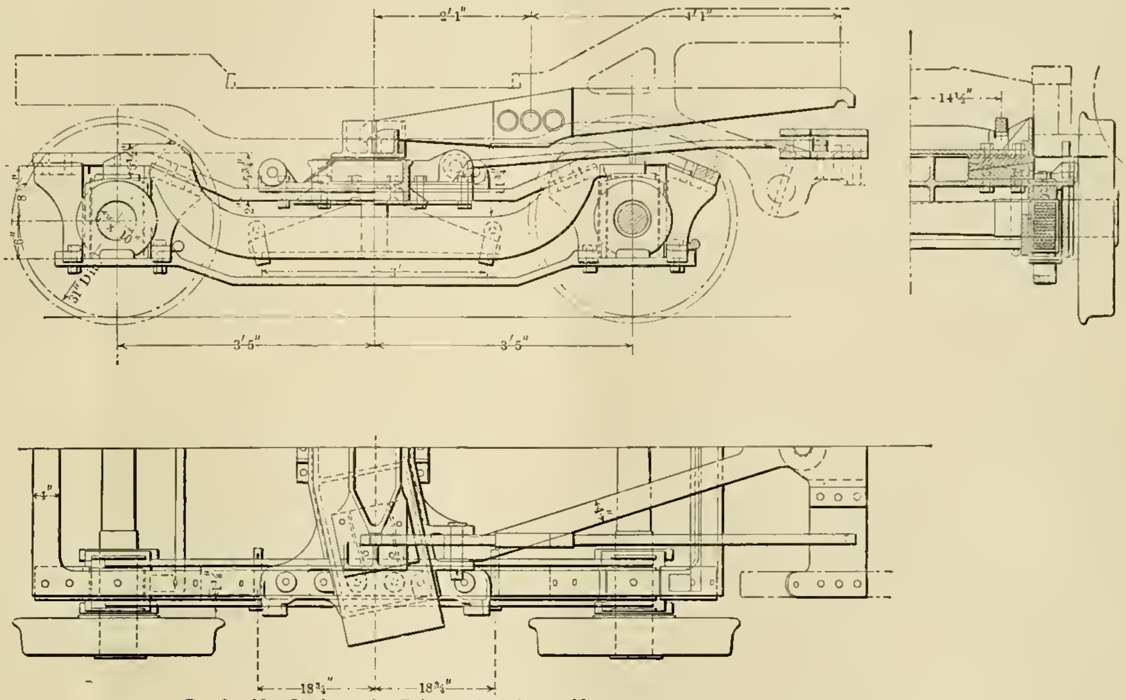




FRONT BUMPER.

thrusts and also protect the cylinders is of a much stronger construction than the rear. There is a 15 in. channel facing, but the top and bottom cover plates have been made ½ in. thick and strongly reinforced by 3½ x 3½ x ⅜ in. steel angles. There is a steel casting between the frames which backs up the draw-

9⅜ in. long. All of the side stays underneath the front tanks are flexible and a new system of cross braces for the roof sheet has been used. There are 8 of these braces, 1½ in. diameter, connected to the roof sheet by 5 x 3 in. tees, so located as to prevent bulging of the roof, which reaches a maximum at a



FRONT ENGINE TRUCK.—C. P. R. SUBURBAN LOCOMOTIVES.

head and also has flanges to which the top and bottom cover plates are bolted.

The front tanks, cab and rear tank are built up together in such a way as to be continuous from front to back, and, as the front tank is secured to the boiler at a point just back of the cylinders where there is no expansion, which means that it is rigid with the main frame, and, as the rear tank and cab construction is solidly braced to the frames, the boiler does not expand, carrying the cab back with it, as with the usual construction, but is free to move backward between the front tanks into the cab, although supporting at the same time the weight of the rear end of the front tanks. This has been arranged by making the front plate of the cab ¼ in. thick and reinforcing it by a 3 x 3 x ⅜ in. angle which rests on top of the boiler and extends outward on each side to bolt to a lug on the top of each side tank. This angle is not studded to the boiler, but rests on a smooth filling strip on its roof sheet to permit of free movement without putting any strain on the cab front or tanks.

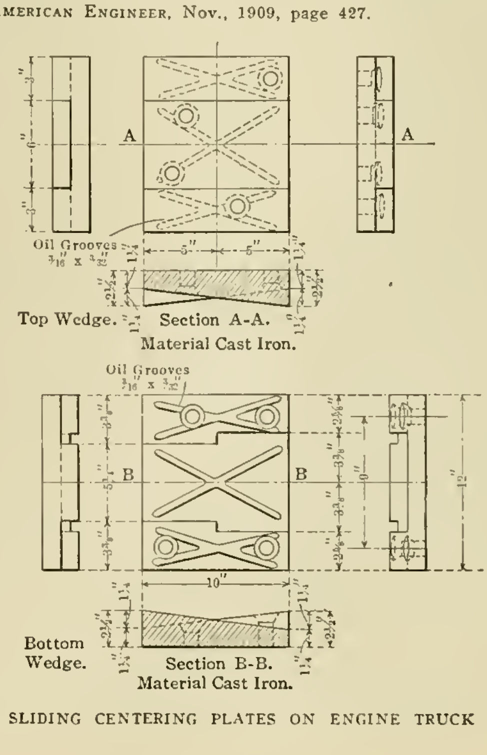
Both tanks and cab are of the usual plate construction, strongly braced, the tanks have a system of splash plates so arranged as to effectively break up any surge of water from end to end. The top of the front tank is in line with the top of the rear tank on which the filling hole is located and two 7 in. equalizing pipes connect them together.

Frames.—Cast steel main and front frames are in one piece and the rear frame of wrought iron are let into a machined fit 1 in. deep and bolted on by 11 bolts 1⅛ in. diameter. Through the use of Walshaert valve gear it was posible to liberally cross-brace the frames. At the front is the front bumper casting followed by the cylinders, guide yoke and yoke sheet, link bearing cross-tie and waist sheet, front expansion brackets and plate, back expansion brackets and plate, rear engine truck cross-tie and back bumper. The back tank itself is also built down to the frame and secured to it by two 3 x 3 x ⅜ in. steel angles, and, as the bottom of the tank is supported by two crossbars of 5/16 in. steel plates, the whole construction is exceedingly rigid.

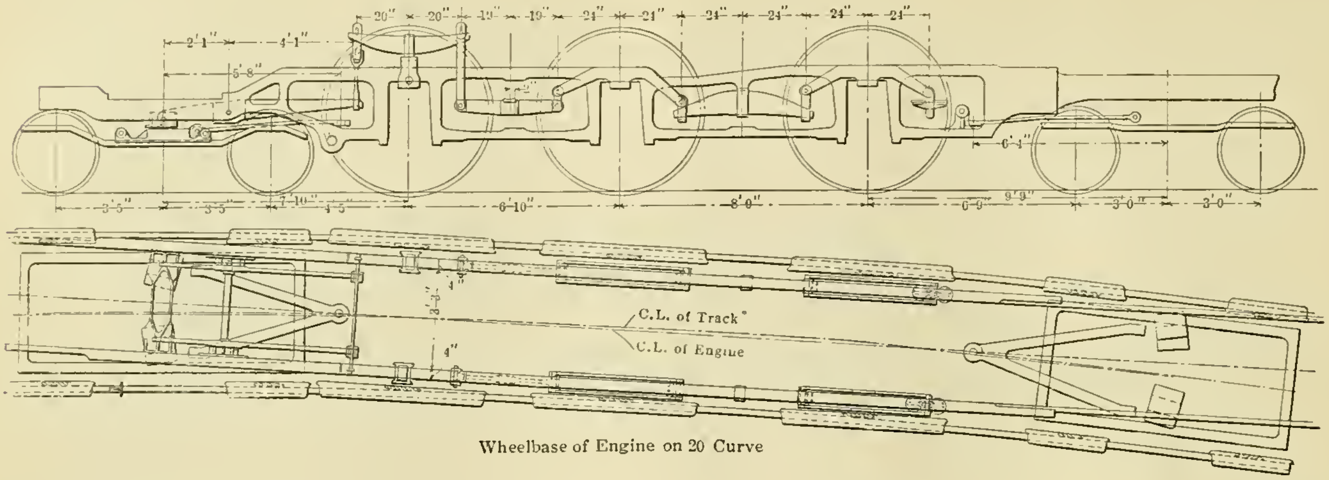
Boiler.—This is of the extended wagon top type, with medium width firebox. There are 173—2 in. flues and 22—5 in., all 13 ft. point just above the crown. The boiler, although not strictly of the wide firebox type, has ample capacity to supply steam to the cylinders at any speed; this is shown by the "B. D." factor of 753 well within the limits of good practice.

The injector check is of the latest Canadian Pacific type* located on top of the boiler 30 in. back of the flue sheet and is placed underneath the bell stand. The check casting proper combines the discharge from both injectors and also has a con-

* See AMERICAN ENGINEER, Nov., 1909, page 427.



SLIDING CENTERING PLATES ON ENGINE TRUCK



Wheelbase of Engine on 20 Curve

nection for a blow-off pipe. An inside deflector plate serves to distribute the water after entering the boiler.

Cylinders and Valve Gear.—These are of the inside admission piston valve type with the valve chambers cast inside the main frames. This necessitates a rocker at the front end to transfer the line of motion from the radius bar on the outside of the driving wheels to the valve stem inside the frames. The front cylinder heads are of cast steel and the back cast iron, lugged for alligator type guide bars. The valve gear is of the Walschaert type and the details are of the Canadian Pacific Railway Co.'s usual construction, except that they have been made lighter than any previously used on this road. Two 3 in. vacuum relief valves are used connecting to each steam chest.

Spring Rigging.—The engine is equalized from the front truck to the back driver with equalizers on each side of the front truck. The back truck takes its weight direct from the frame and in this way the points of support are as though the engine had four pairs of driving wheels equalized together and a four-wheel center pin leading truck. Both trucks, although of the four-wheel type, have radius bars, and the length of these bars has been determined with a view of making the rear wheels do some of the guiding and relieve the front wheels of excessive flange wear.

This is best explained by referring to the diagram which shows the wheel base of the locomotive on a 20 degree curve, and the lengths of the radius bars are such that when taking a curve the front flange bears against the outside rail and the rear flange on the same side is also brought close to it instead of the outside leading and inside back flanges bearing, as is usual, with trucks of this type. Side movement of the truck has been provided for by a system of slides having an incline of 1¼ in. in 10 in. These inclines have a centering effect of 8,100 lbs. and work in an oil bath formed by flanges on the supporting cross-tie on the truck, in this way uneven wear should be prevented. The truck radius bar and driving equalization systems present a novel and interesting arrangement, but the results obtained in service more than justify the innovation.

Driving Wheels, Rods and Boxes.—The driving wheel centers are of cast steel with pear section spokes and arch section rims; cast iron hub liners are let into and studded to the hubs. These run on babbitt faces on the driving boxes.

Supplementary counterbalance weights are used in conjunction with the ordinary balances opposite the cranks and the wheels are balanced in accordance with the system worked out by H. H. Vaughan and fully described in the AMERICAN ENGINEER AND RAILROAD JOURNAL of October, 1909. The computation for one of these engines is reproduced in the adjoining table.

The side and main rods are I section forged from mild steel with strap connections on the back end of the main rod and main crank pin.

All driving boxes are 9 x 12 in. and the faces in contact with shoes and wedges have brass liners studded and lugged to the boxes. Grease lubrication is used throughout.

Guides.—The guide bars are of mild steel arranged for a crosshead of the Alligator type, with yokes of Universal Mill plate 1½ in. thick, made in three pieces. The cross plate suspends the legs, which are bolted to it with nine 1⅛ in. bolts, these in turn carry the guide bars by double cast steel knees.

Removable sectional liners are used on the crossheads, which are exceedingly light for a crosshead of this type. They each weigh but 350 lbs. complete. The sectional liners may be replaced when worn without disconnecting the crosshead by simply removing the side plates held in place by six ⅞ in. bolts. This is one of the most successful types of crossheads which has

COMPUTATION OF COUNTERBALANCE WEIGHTS.

ENGINE 1991. CLASS T2A. WEIGHT 239,000 LBS.

WEIGHT OF RECIPROCATING PARTS.

Piston and rod		=	165 lbs.
Crosshead complete		=	350 "
Proportion of main rod (reciprocating)	Front end	=	215 "
	1/6 back end	=	65 "
Total for one side of engine		=	1,095 lbs.

WEIGHT OF ALL PARTS ROTATING AT CRANK PINS.

Leading wheel.	Front end of leading side rod	=	145 lbs.
Main "	Back " " " " " = 240; Front " " trailing " " = 245; Prop'n of main rod (rev'l'g) = 315	=	800 "
Trailing "	Back end of trailing side rod	=	145 "
Total for one side of engine			1,090 lbs.

NOTE.—In the succeeding data, all the rotating weights on wheel are reduced to the radius of the crank pin as follows:

$$\text{Equivalent weight at crank pin} = \frac{Wx}{R}$$

W = Actual weight of any mass.
x = Distance of its C. G. from center.
R = Radius of crank pin.

	Leading. Right.	Leading. Left.	Main. Right.	Main. Left.	Trailing. Right.	Trailing. Left.
Weight hung on pin to balance the counterbalance weight	365	370	1,070	1,045	400	390
Rotating weight at crank pin	145	145	800	800	145	145
Direct overbalance	200	225	270	245	255	245
Supplementary balance weights	120	120	120	120	120	120
Total overbalance, avg. of R. & L.	342 lbs.		377 lbs.		370 lbs.	

Total reciprocating weights = 1,095 lbs.
Sum of total overbalance = 1,089 "

Total horizontal unbalance = 6 lbs. or .0025% of weight of engine.

Maximum overbalance on any wheel = $\sqrt{270^2 + 120^2}$ = 295 lbs., or 1.22% of wheel load in R. main.

Transverse unbalance = total reciprocating weight — (total overbalance — total supplementaries).

Transverse unbalance = 1,095 — (1,089 — 360) = 366 lbs. or .15% of engine weight.

Total Horizontal Unbalance is the unbalanced part of the reciprocating weights, which by its inertia, tends to move the engine as a whole forward or backward on the track.

Transverse Unbalance is the unbalanced part of the reciprocating weight, which by its inertia causes a nosing motion.

Maximum Overbalance is the unbalanced revolving weight, which by its centrifugal force increases or decreases the pressure of the wheel on the rail. The force due to this weight, if large, may exceed pressure of wheel on rail, and lift the former against the springs, with possible damage to track.

ever been used by this road, and the difficulty of slack between the crosshead and bars has entirely disappeared since the adoption of this style of renewable shoe.

Superheater and Smokebox.—Single, adjustable draft pipes are used with a 5½ in. exhaust nozzle and 14½ in. taper stack, draft through the 5 in. tubes which contain the superheater is controlled by an automatically operated damper which cuts it off when steam is not being used. Considerable difficulty is experienced with operating cylinders in general and experiments are now being made as to what would be the action of the fire on the superheater pipes if the damper cylinder and automatic damper were omitted altogether.

A throttle of an ordinary type arranged to take steam at the top and having no drifting valve is employed.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Suburban
Fuel	Bit. Coal
Tractive effort	28,100 lbs.
Weight in working order	236,000 lbs.
Weight on drivers	135,000 lbs.
Weight on leading truck	49,340 lbs.
Weight on trailing truck	51,660 lbs.
Wheel base, driving	14 ft. 10 in.
Wheel base, total	38 ft. 10 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.80
Total weight ÷ tractive effort	8.40
Tractive effort × diam. drivers ÷ heating surface	753.00
Equivalent heating surface ÷ grate area	71.00
Firebox heating surface ÷ total heating surface, %	8.65
Weight on drivers ÷ equiv. heating surface	57.40
Total weight ÷ equiv. heating surface	100.00
Volume both cylinders, cu. ft.	9.50
Equiv. heating surface ÷ vol. cylinders	248.00
Grate area ÷ vol. cylinders	3.48
CYLINDERS.	
Kind	Simple
Diameter and stroke	20 x 26 in.
VALVES.	
Kind	Piston
Diameter	12 in.
WHEELS.	
Driving, diameter over tires	63 in.
Driving journals, diameter and length	9 x 12 in.
Engine truck wheels, diameter	31 in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	31 in.
Trailing truck, journals	6 x 10 in.
BOILER.	
Style	Wagon Top
Working pressure	200 lbs.
Firebox, length and width	114 x 41⅞ in.
Firebox plaets, thickness	⅜ & ½ in.
Firebox, water space	F. 4, B. 3, S. 3½ in.
Tubes, number and outside diameter	22—5, 175—2 in.
Tubes, length	13 ft. 9⅜ in.
Heating surface, tubes	1,045 sq. ft.
Heating surface, firebox	156 sq. ft.
Heating surface, total	1,801 sq. ft.
Superheater heating surface	366 sq. ft.
Equivalent heating surface	2,350 sq. ft.
Grate area	33.1 sq. ft.
Smokestack, diameter	14½ in.
Smokestack, height above rail	181 in.
Center of boiler above rail	104⅜ in.
TANKS.	
Water capacity	3,000 gals.
Coal capacity	4 tons

PROPOSED USE OF THERMAL UNITS AS THE MEASURE OF BOILER POWER*

For over thirty years engineers and engineering teachers have been apologizing for the use of the term "boiler horsepower." Even the committee of the society which reported in 1884 says: "It cannot properly be said that we have any natural unit of power for rating steam boilers." If a horse power is the rate of doing work, and a boiler is considered as a machine, and the water as the moving parts, the only mechanical power that a boiler produces is that due to the external latent heat of evaporation, except when it explodes. Hence the term "boiler horsepower" is a misnomer. The object of the use of a boiler is the absorption of the heat energy obtained from the potential energy of the fuel by combustion, and its transfer to and storage by a volatile liquid for convenient use in a heat engine, or for other thermal purposes. Hence as a boiler uses the latent heat energy of the fuel as its source of supply and develops and delivers available heat energy, there would seem to be every reason why the power or ability of a boiler to deliver energy should be measured in thermal units, as being the only unit of energy that the boiler ever normally receives or delivers. Furthermore, the energy from every boiler is always measured in heat units before being reduced to boiler horsepower.

To measure the capacity or power of a boiler plant, or its output of energy, in millions of thermal units would not be practical; a smaller unit is desirable. It is therefore proposed to measure the power or capacity of a boiler in "boiler powers," and to define a boiler power as 33,000 B. T. U. of heat energy delivered per hour by a steam boiler, steam main, or by a hot-water heating main, or the like, or added per hour to the feed water of a boiler, or to the water of a hot-water heating system. The acceptance of this term will, it is thought, simplify the whole subject; the unit will remain constant, will be easily remembered and easily used, and will not be one of three standards, differing slightly among themselves, as is at present the case with the term boiler horsepower. Its analogy to mechanical horsepower will be helpful rather than the opposite, especially to the beginner in engineering knowledge. The unit boiler horsepower may still be retained by those who may prefer to use it in some one of its many thermal values.

* From a paper by Prof. W. T. Magruder, of Ohio State University, before the American Society of Mechanical Engineers.

FAST RUN WITH A SUPERHEATER LOCOMOTIVE ON THE LONDON AND NORTH-WESTERN RAILWAY

A test run was made recently on the London and Northwestern Railway with Mr. Bowen Cooke's new 4-4-0 simple "George the Fifth," equipped with the Schmidt system of superheating, has produced some very interesting data which well illustrates the high speed possibilities of a locomotive when so equipped and intelligently handled. It is intended that the tests will be of a competitive nature between the "George the Fifth" and a non-superheater, the "Queen Mary," both engines being identical in every respect, with the exception that the latter has one inch less cylinder diameter. The comparative performance of the two engines under the same conditions has not as yet been reported, but that of the "George the Fifth" is not lacking in individual interest.

The principal dimensions of this engine are as follows:

Cylinders	20 x 26 in.
Driving wheels	81 in.
Driving wheel base	10 ft.
Boiler diameter, outside	60¾ in.
Firebox, length and width, outside	88 x 49 in.
Total heating surface	1,849.6 sq. ft.
Steam pressure	175 lbs.
Weight of engine in working order	133,840 lbs.
Weight of tender in working order	82,880 lbs.

The train was composed of:

Thirteen eight-wheel coaches	722,960 lbs.
Dynamometer car	76,160 lbs.
Total weight of engine, tender and train	454.24 tons

The distance from Crewe to London is 158 miles, and on the south-bound, or "up" trip, a stop was made at Rugby. The mean speed from Crewe to Rugby was 53¾ miles per hour, and from Rugby to London, 58¼ miles per hour. On the non-stop return trip the high average of over 60 miles per hour was attained, the actual running time being 157 minutes for the 158 miles. With this train the maximum speed reached 78½ miles per hour, 5 miles better than on the up trip. The highest indicated horsepower noted during the round trip was 1,229¼.

It is intended that the "Queen Mary" shall alternate in exactly the same service, and the tests will be continued, fairly and impartially, until sufficient data has been gathered to practically decide the superheat question on the London and Northwestern. It is interesting, however, to note in this connection that although the trial runs are unfinished, Mr. Cooke is building nine additional engines of the "George the Fifth" class and eight new 4-6-2 tank engines, all of which are equipped with superheaters.

The Chilean Government has 1,677 miles of railway completed and 1,346 miles under construction, while private interests have 1,920 miles completed and 106 under construction.

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CONTENTS

R. H. ROGERS

It is with pleasure that we announce the addition of Robert H. Rogers to the editorial staff of this journal.

Our readers will recognize Mr. Rogers as the author of a number of very valuable contributions to these pages, the most recent being a series of three articles on "General Locomotive Inspection," followed by an interesting discussion on "British Locomotive Development," which appeared in our last issue.

Mr. Rogers' experience, combining as it does several years of newspaper work, together with a long and diversified service in the motive power departments of various railways, is one that particularly well fits him for this position. He is a graduate of the Baltimore Polytechnic Institute and entered railway service as machinist apprentice on the Baltimore & Ohio Railroad, following which he was a machinist for three years, and in 1895 was made general piece work inspector of that system. His next promotion was to roundhouse foreman at the Pittsburg terminal, which position he resigned to become shop foreman on the Mexican Central Railway at Mexico City. In 1898 he resigned from this position and for the next three years was on the staff of the Philadelphia *Times* and the *North American*. Leaving newspaper work to again take up railroading, he reentered the service of the Baltimore & Ohio as locomotive inspector at the Pittsburg and Richmond Works of the American Locomotive Co. Upon delivery of the locomotives being built he became assistant master mechanic at Mt. Clare, and later general foreman at Cumberland, Md. In February, 1905, he was appointed master mechanic of the N. Y. N. H. & H. Railroad, at South Boston, Mass., and on Jan. 1, 1908, he undertook the general and thorough inspection of the locomotive equipment of the Erie Railroad, upon the completion of which he spent several months in foreign countries studying locomotive practice.

MANUFACTURE OF PRESSED STEEL CAR SHAPES IN RAILROAD SHOPS

If a railroad owns a flange press, and the majority of the lager ones do include this appliance in the boiler shop layout, there is no valid reason, waiving, of course, the consideration of first costs, why it should not have additional employment in making pressed steel car shapes for renewals. A flange press in a repair shop is practically a dead tool; that is, so far as its full capacity in the output of boiler and firebox parts is concerned, and its use in the connection suggested should in no manner interference with its regular work.

In reviewing questions connected with pressed steel car repairs we have prominently in mind the success which has attended the efforts of the Philadelphia and Reading Railroad in thus extending the scope of the flange press to include car work. With about 14,000 cars on that line to maintain, one press easily keeps up with the requirements. It has not been found necessary to purchase a shape in nearly four years, and since the plan has become fully developed, the advantage, from an economical standpoint, is remarkable.

For instance, one shape, an end sill, was turned out at home for about $2.55, including labor and material, and which when formerly purchased cost $12.50. This is admitted to be a rather forcible, although a true illustration, but at all events there is no hesitancy in asserting that from 50 per cent. to 75 per cent. should be saved with the proper appliances, over the purchase price of any car shape.

It is appreciated that certain barriers interpose to the scheme, but still these are far from being insurmountable. The principal bugbear, of course, is the inevitable pattern shop delay, and the initial cost in getting out the patterns for the dies. With these items must also be reckoned the drafting room expense in connection with preparing the blue prints for the pattern makers. The cost incidental to machining the dies when received from the foundry is so comparatively insignificant that it need scarcely be considered. We believe that in view of the fact when the dies are finally out they will serve for practically all time, justifies the outlay, especially when the strong argument intrudes of the saving which can be made over buying the shapes from outside firms.

Our thought was that if not considered advisable to proceed on the elaborate scale which has characterized the Reading Railroad, it might be well to select, say ten shapes, which represent the most renewals. These are ordinarily end sill face plates, end sills, draft channels or sills, coupler horn braces, end sill reinforcing plates, end sill diaphragms, bottom follower guides, center stakes and joint stakes.

Dies might be made for these parts at odd times, and in the order in which the general storekeepers books indicated as implying the greatest consumption. It is far better to proceed cautiously in this manner, and to the point, because experience has shown conclusively that much time and money will be expended without definite results if it is attempted to put into use too many dies at once. When it is known, however, that the dies are out, and right, for any particular shape, it simply resolves into turning them off the press as fast as desired, or as the requirements warrant.

POST THE SHOP FORCE ON ENGINE FAILURES

It is unfortunate that shopmen, and particularly roundhouse men, do not have a more intimate knowledge of locomotive performance on the road. Very few of them seem to know what is giving the most trouble on their own division. Through an investigation recently conducted into a series of engine failures resulting from hot main pins on a prominent eastern railroad, the fact stood fully revealed that the large majority of the force were in ignorance that the trouble had virtually assumed the proportions of an epidemic, and one sufficient to delay several through passenger trains in a single day on one grand division of the system. They knew vaguely, of course, that main rod brasses were warming up, but could not appreciate the gravity of the situation because it was not presented to them in concrete form.

Therefore the thought suggests in this connection that to post a copy of the daily engine failure report, with such further explanatory matter as the master mechanic cared to make, on the shop bulletin board, would prove of great value in awakening interest, with a very good resultant effect. Entirely too much mystery enshrouds this report, as it is now generally handled. Probably this is because if it is bad the division motive power management is ashamed of it, and if blank, beyond a few expressions of felicitation in the office, it is quickly forgotten. At all events, it seldom leaves the office and the workmen are unaware whether the performance of their locomotives is good or bad.

It is felt that if the workmen knew the troubles which are occurring, local pride in their shop, and their natural desire to get ahead, would permit them to see at least that their part of the work is properly performed. It is as confidently believed that this report would be consulted and discussed every day, and through such subtle means as only the skilled workman can command, a permanent improvement would quickly ensue. Humanity is practically the same, whether in overalls or silk, in its desire to possess the confidence of superiors, and there is no better way to reach a workman than to make him really feel that he is no unimportant unit in the general scheme.

AN UNIVERSAL BOILER DISCUSSION

In all of the voluminous reports associated with the eighth session of the International Railway Congress there is probably embodied no more interesting subject to railroad mechanical supervision at large than the boiler question, which this particular session prominently featured. Fortunately it was decided long ago that this important matter should receive thorough analysis; an analysis which should include design, development, and last but not least, maintenance, and it is doubly fortunate that the reporters selected to represent the various countries of the world were men of conceded ability and world-wide reputation. In consequence, through their efforts a wealth of hitherto unsuspected material has been unearthed. In these reports we are taken into the inner councils of the designers; brought face to face with actual roundhouse conditions in foreign lands, and are presented with compelling statistics in support of views which might not otherwise appeal to us.

Actuated by these considerations, we regard the article in the current issue on the general subject of the locomotive boiler as of particular value at this time. While in a sense it is a compilation of the Railway Congress reports, nevertheless a certain latitude in drawing comparisons between foreign practices and our own practices is evident which carries a particular appeal, and which after careful study may result in some good.

It is, of course, unfortunate that the reporters, with few exceptions, did not give reasons for their views, and it is disappointing that the tenor of the reports in general does not convey much assurance that locomotive boiler development is progressive, but still the thoroughness with which the matter has been covered, and the tremendously important scope of the organization before which it was presented, conveys the hope of ultimate uniformity in design and methods, the lack of which is certainly painfully apparent at present.

NO ECONOMY IN CHEAP FUEL

In the committee report on fuel economy, presented at the recent convention of the Traveling Engineers' Association, one subdivision, viz., "whether it is more economical to buy cheap fuel of a low heat value, or a higher price fuel of a greater heat value," was of particular interest, as therein the committee, departing from the time-honored traditions of motive power propaganda, suggested that occasional engine failures were more economical than paying for good coal.

Following is the text of this portion of the report:

> The purchase price of coal has considerable to do with the kind of coal used. A number of the roads use coal that is mined on their own lines, and while this coal may not compare favorably with coal from nearby coal fields, the cost of transporting the other coal prohibits its use; but when the before mentioned conditions are not of great concern, we believe it is more economical for any railway company to use the cheapest grade of fuel they can get along with and keep the delays on the line down to a minimum.
>
> It is more economical to have an occasional engine failure on account of poor coal than it is to pay $75 to $100 a day more for coal on one division.
>
> On the average division from 600 to 1,000 tons of coal are consumed per day. If the price of coal is advanced 10 cents a ton, the cost is increased from $75 to $100 per day. Therefore it is a question of how many engine failures a road can afford to have for $75 to $100 a day, due to burning an inferior grade of coal.

This may be all right in the abstract, as an engine failure, at the moment, really costs nothing, but it is extremely doubtful if such conclusions will be viewed with favor by operating department heads. In every scheme of organization the efficiency of the motive power, and this means at least fifty per cent. of the efficiency of the service, is practically based on locomotive performance. Any failure of a locomotive to do its work on the road becomes at once the subject of an inquiry regarding the cause, which is followed with more persistence than is probably accorded to any other detail in the entire organization.

On many roads "poor coal" is no longer accepted as an explanation or as an excuse for low steam. In the majority of instances the coal is good, but if bad the fact should never be, and is not, admitted. This, of course, is to avoid the inevitable demoralization which must necessarily follow, not only among the engine crews, but in reflection throughout the entire mechanical department as well.

The work of a conscientious and skilful fireman might remain unaffected under such conditions, but it is a well-known fact that a large per cent. of firemen are not so constituted, and will not make the necessary effort unless convinced that excuse or evasion will be of no avail. Needless to add, it would be the prompt relaxation of these men to which could be traced the origin of a disgraceful failure sheet, and which would promptly follow should the suggestion which forms the basis of this mention be carried out.

Instead of so putting a premium on indifference and incompetency, it is far better to buy the best coal procurable and set a tangible monetary premium on economy of fuel for both the engineer and fireman. This is the plan largely followed in other countries than our own, and it is equally applicable here as there. The immediate gratifying result will be large decrease in fuel consumption, increased efficiency, and last but not least, a spirit of hearty cooperation, which is now, unfortunately, too often lacking.

THE IMPROVED BAKER-PILLIOD VALVE GEAR

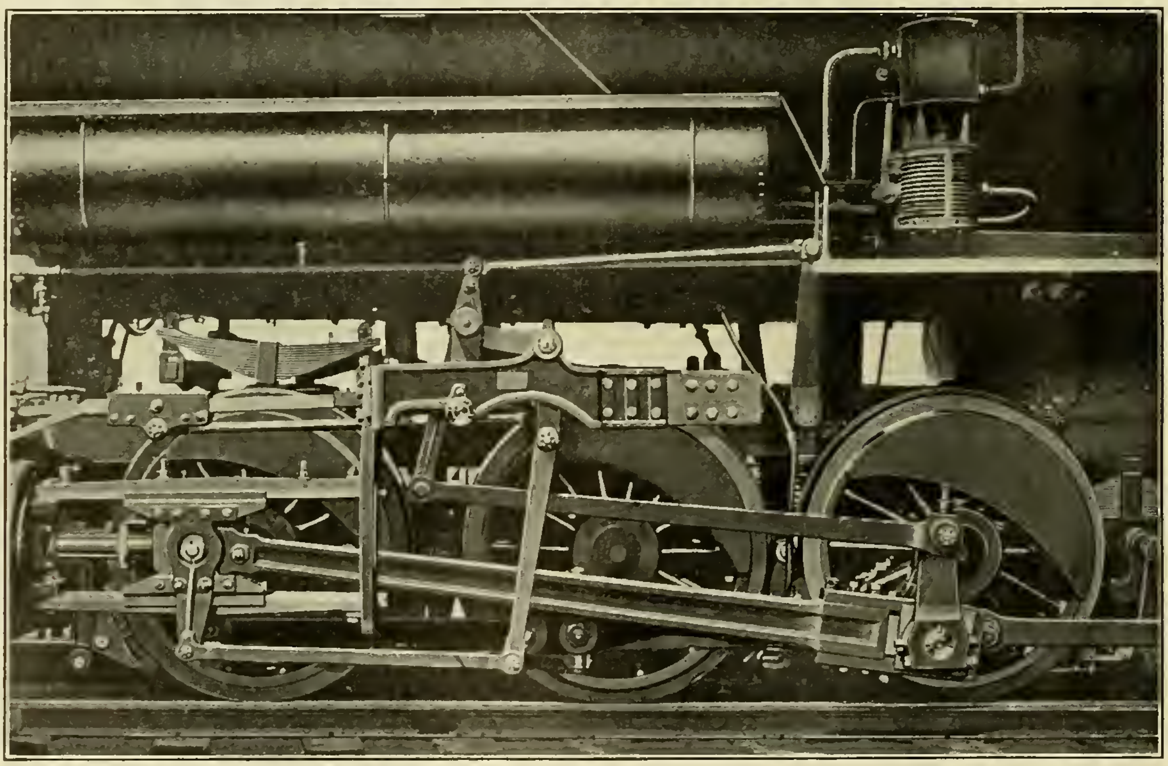
One of the most important problems which the rapid locomotive development of the past few years has presented to motive power management in general is the consideration of the most efficient, practical and economical method for effecting steam distribution, and in this connection it is of much interest to note that at the present time certain types of radial valve gears are viewed with particular favor as embodying excellent features toward securing the ends desired.

A prominent example of this development is afforded in the improved Baker-Pilliod valve gear, manufactured by the Pilliod Company,* and which has been applied to many recently built locomotives. It is primarily designed to obviate the inherent defects which accompany the fixed or the shifting link, and to provide a simple manipulating and actuating device in combination with the standard slide or piston valves. The service returns from where applications have been made indicate that higher speed is possible with this gear; that a reduction in running repair costs has followed, and that more tonnage can be hauled with less fuel and water.

in England and on the continent, and others not so generally known. Despite the popularity which these gears now enjoy, especially the former, it is nevertheless fully realized that there are certain errors in their design, the presence of which cannot be disputed. For instance, the slipping of the link block is a source of error in all motions, whether the radial link is fixed or shifting, but it is much more prominent in the latter case, arising from the much longer arc in which this form of link travels in comparison with the arc described where the link oscillates upon a fixed center.

This is the principal disadvantage of the Walschaert gear, and there is theoretically another in the fact of its constant lead, which may become apparent when the motion is applied to a locomotive intended to be operated at any considerable range of speed. In addition to the presence of the former defect in the Joy motion it has further disadvantages, arising from the number of its parts and joints liable to wear loose; more connecting, or main rod failures, and the interference which the vertical play of the main axle on a rough track exerts with the regular steam distribution.

It was to overcome these objectionable features that the Baker-Pilliod valve gear was originally designed. One of these inti-



IMPROVED BAKER-PILLIOD DESIGN OF VALVE GEAR AS APPLIED TO A CONSOLIDATION LOCOMOTIVE

The old design of the Baker-Pilliod gear has been fully described and illustrated in this journal,† and its underlying principles, which of course, still apply, are no doubt fully understood, but before proceeding with a comparison between it and the present design it may be well to mention the subject of radial valve gears in general, in order to better make apparent how ordinarily existing defects have been overcome in this arrangement. The name radial valve gear has been applied to a number of reversing gears differing widely in general appearance and detail, but alike in basic principle, inasmuch that they all derive the mid-gear motion of the valve from some source that is equivalent to an eccentric with 90 deg. angular advance, and that they combine with this motion another equivalent to that of an eccentric with no angular advance.

Well-known examples of this design are the Walschaert, for which in this country the enormous increase in the size of locomotives was largely responsible; the Joy, which is extensively used

mately associated with the Walschaert is link block slip. It will be noted that the motion is pinned throughout; that the link is eliminated, and with it the error in the motion which is identified with link block slip. This is one of the most interesting features in this gear and particular stress is laid upon its unquestioned advantages. It might be added in this connection that all pins are in double shear. They are taper fitted, amply keyed, and equipped with castellated nuts, and every pin is so exposed that it is easily accessible for removal.

The improvements which have been made in the old design were by reverting to the original Baker patents, and by certain changes and valuable re-arrangement of details, which through comparison will become readily apparent. These have eliminated the original cumbersome character of the motion, and have established many features of advantage in construction which heretofore have been lacking.

The frame is now made in one piece instead of two, and the same casting serves for either side of the engine, replacing four castings which the former design necessitated. Another clever

* 30 Church Street, New York.
† See American Engineer, January, 1909, page 32.

idea in connection with this part, and which has been well developed, was to provide the frame with an extension which will permit it to be used on a great variety of engines. It will no doubt be recalled that in the old design each locomotive class had to carry a special frame, therefore an important move has been made toward standardization.

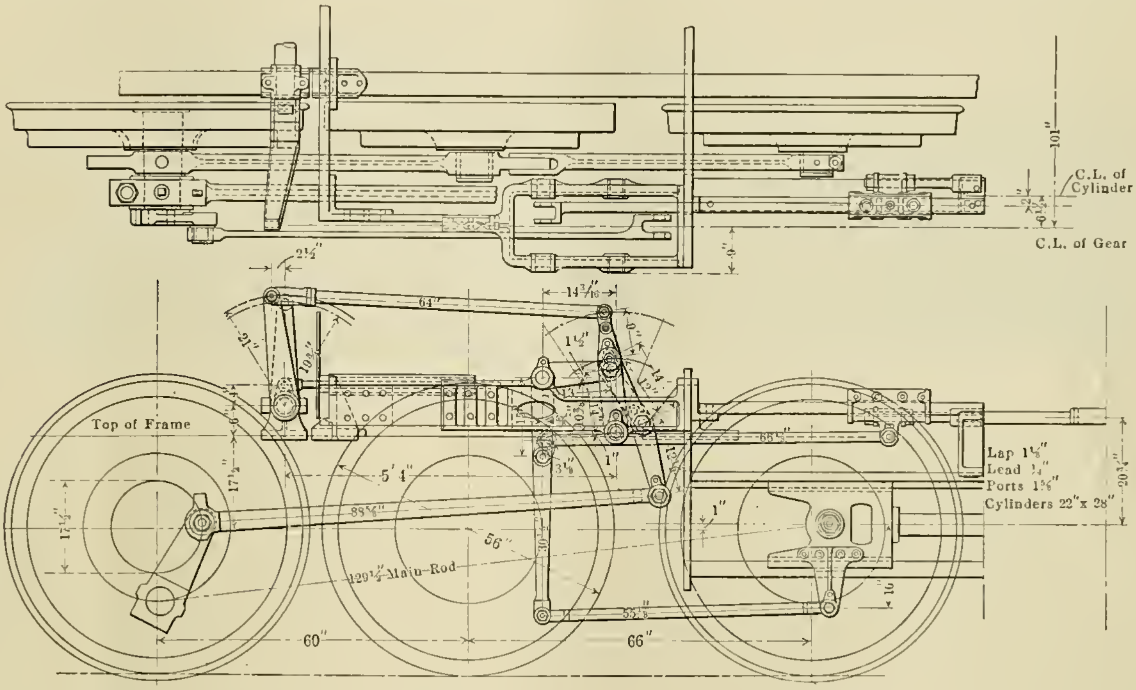
This is also noticeable in connection with other parts of the gear, particularly the bell crank, of which formerly a variety had to be used, on account of valve travel, while now it is possible to obtain sufficient travel and use the same bell crank for all classes. The new design of the latter, which is centrally hung from the frame, carries two vertical arms instead of one, and its position has been shifted forward so that the vertical arm connects to the gear connection rod, while the horizontal arm is on the center line of the gear.

A very important change has also been made in the combination lever which has been removed from the frame and hung between the two vertical arms of the bell crank. This arrangement greatly reduces the work formerly imposed upon the combination lever, as it no longer carries the weight of the back end of the eccentric arm and the front end of the eccentric rod, and it permits the use of a straight form lever similar to that employed in the Walschaert gear. Thus the new design materially improves this part, and dismisses the wear of the former bell crank pin, which in the old design of bell crank combination lever was an endless source of annoyance.

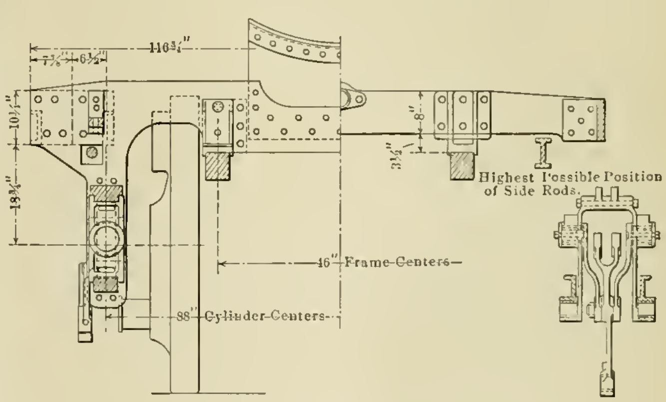
One of the most vexatious questions connected with the former gear was that of eccentric rod angularity, which, although not particularly prominent when a long rod could be used, was quite noticeable with the short rod which was often necessary. The bad effect of this feature has now been done away with by the use of the gear connection rod, formerly called the gear valve rod, through which it is possible to drop the front end of the eccentric rod to a point sufficient to minimize or eliminate all angularity. The gear connection rod also dispenses with the former eccentric arm, thus removing a part from the mechanism. It now connects the bell crank with the lower end of the radius bar, and continues on down to connect with the front end of the eccentric rod.

With the old gear the tumbling shaft was of the rocker arm design, as the direction of motion of the reverse lever had to be reversed. Now that this is no longer necessary the reach rod is straight from the yoke to the reverse lever, and furthermore the reach rod connects with the top of the yoke at the center, instead of on the inside, as was formerly the case. The yoke itself has not been neglected in the general betterments which have been accorded the motion, as it now lies forward in the go ahead position instead of backward, which was an unique and somewhat questionable characteristic of the former arrangement.

Special attention has been paid to the alignment of the gear in general. This is quite clear after a superficial study of the parts, which will plainly show that everything is centrally hung except the combination lever, and the reason advanced by the manufacturers for this exception is because this means is used to get from the center line of the eccentric rod to the center line of the valve. If there is to be any twisting motion at all in this gear as now improved it appears that the combination lever will be the only part to be effected, whereas in the original design undue stresses were imposed on many of the vital working parts.



GENERAL ELEVATION AND PLAN OF IMPROVED BAKER-PILLIOD VALVE GEAR



CROSS SECTIONS THROUGH VALVE GEAR

In their effort to thoroughly enhance the value of the new arrangement the Pilliod Company have not neglected the small details which so often become subjects of criticism. This is well exhibited in the care taken to provide an adequate oiling system, wherein every bearing, regardless of how much movement it may have, is equipped with an oil cavity which is integral with the part. On the larger bearings this cavity is very long, and there are two oil holes for proper distribution. This is a strikingly different arrangement from that of the old gear which was equipped entirely with loose oil cups, or mere oil holes.

It may be said also that the re-arrangement of parts embodied in the new design obviates the necessity of so many oil holes, and they are consequently greatly reduced.

As has been mentioned, the new design does away with the curved path of the front end of the eccentric rod, which in its original form was an irregular circle, transforming it into an arc, which permits the valve events to be more nearly square in all positions, back up as well as go ahead. It is also possible to equalize the port openings in full gear which could not be attained before these improvements were made. It can be readily seen that the Baker-Pilliod will produce a greater range of valve events by reason of permitting numerous modifications.

HIGH SPEED LOCOMOTIVE FITTED WITH THE IMPROVED BAKER-PILLIOD VALVE GEAR

In view of the fact that this device demonstrates satisfactorily that the motion of a slide valve can be perfectly controlled, and the length of stroke varied, without the intervention of a radial link, a real gain in the economical use of steam has been made. The ideal valve gearing for a locomotive must have the element of rigidity in a marked degree, and at the same time possess that flexibility of adaptation essential to the requirements of the service. These features appear to be happily realized in this construction, in the re-design of which the fact was borne prominently in mind that the best use of steam pressure is possible only when under perfect control.

NEW SHOPS AT EMPALME, MEX.

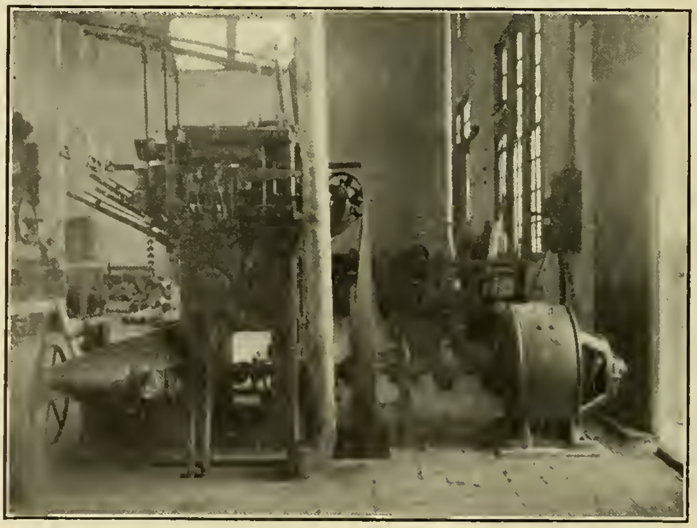
SOUTHERN PACIFIC R. R. OF MEXICO.

The general shops of the Sud-Pacifico de Mexico, herein illustrated, are located at Empalme, Sonora, the junction of this railroad and the Sonora Railway. About five years ago, when construction of the Cananea, Yaqui Railroad was started at a junction with the Sonora Railway, five miles east of Guaymas, the present site of Empalme was a waste covered with cactus, with not a single improvement except the bare lines of an old railroad. To-day it contains an up-to-date shop plant, equal to any west of the Rocky Mountains, and a modern American town site with first-class quarters for the company's employees. This rapid growth was due to the aggressiveness of Epes Randolph, who has been instrumental in the laying out and construction of the Southern Pacific road through Western Mexico, and who deserves practically all the credit for the road and the fine shops at Empalme. The selection of the location was not only because Empalme is central with reference to the lines north and south, but also on account of the climate, which, tempered by a continuous cool breeze from the Gulf of California, is said to be the most pleasant on the Mexican west coast.

Plans for the shop and construction were started about three years ago, and the first building completed was the twenty-eight-stall roundhouse. In this stone obtained from the company quarry 1½ miles from Empalme, was employed, but this construction proved that the rest of the buildings could be erected more economically from concrete, and plans were made accordingly. A test of the soil showed that it would either be necessary to put in large spread concrete footing under the piers carrying the large buildings with traveling crane loads, or to drive concrete piles, and it was eventually decided to adopt the latter plan.

Among the features of this complete plant are machine and erecting shops, boiler and blacksmith shop, material shed, bolt shop, flue shop, foundry, pattern shop, car and paint shops and mill. No detail was omitted to have the shops adequate to take care of locomotive, passenger and freight car repairing and rebuilding, and they are also equipped as a manufacturing plant, making them, to a large extent, self-supporting. Work is also to begin shortly on the erection of the dry lumber storage building and a dry kiln.

Particular attention has been given to labor and time saving devices. Cranes, push car tracks, turntables, floor air jacks, air hoists, etc., have been provided wherever considered practicable, and a telephone system connecting all shops, offices, stores, etc., is installed. A general fire alarm system, with fire alarm boxes located at suitable places about the shops and connecting with the power house, is provided for. An independent fire line with hydrants has been installed and is used only in case of fire or fire drill by the shop fire department, thus insuring piping in good condition that will stand high pressure in case of fire, and



APPLICATION OF DIRECT MOTOR DRIVE TO MORTISING MACHINE

eliminating the dangerous practice of allowing general service and other taps to be connected to the fire line. All buildings are exceptionally well lighted, and, to eliminate the disagreeable feature of the strong sunlight, factory ribbed glass is used throughout. The coal storage has a capacity of ten thousand tons, the coal being dumped from an elevated trestle.

The shops are electrically driven throughout, power being furnished from a central power station, which is a handsome reinforced concrete structure 88 feet wide and 106 feet long. This building is divided longitudinally by a wall extending its full length, separating the engine and the boiler rooms. The engine room floor is about five feet above the boiler room floor, which provides for a basement to accommodate condenser, air pumps, hot well, boiler washing, general service, hydraulic and fire pumps, steam and exhaust headers, and all piping. In the power house there are two Westinghouse 200 kw., three-wire, 250 volt D. C. engine type generators direct connected to reciprocating engines.

There are about 200 Westinghouse type "S" motors, from 1 to 50 h. p., operating the various wood and iron working machinery in the different departments. The machines are all direct driven and the necessity of overhead belts and line shafting is precluded. By means of the adjustable speed motors that are used, the speed control of the different machines is extremely flexible; and hence, a considerable gain in the productive capacity of the machines is made. The flexibility of control is especially advantageous in the machine shop.

GENERAL VIEW OF THE EMPALME SHOPS OF THE SOUTHERN PACIFIC R. R. OF MEXICO

SUCCESS OF THE ERIE'S APPRENTICE SYSTEM

The development of the Erie Railroad's system for the technical training of apprentices is proceeding rapidly, and before long will include practically all points on that system where a sufficient number of apprentices are employed to make the establishment of a school consistent. Those now in operation are at Meadville, Pa.; Susquehanna, Pa.; Dunmore, Pa.; Hornell, N. Y., and Port Jervis, N. Y., and 317 young men are receiving the benefit of a thorough practical course of education without cost to themselves.

HEAVY SLOTTER WITH DIRECT ELECTRIC MOTOR DRIVE IN THE EMPALME SHOPS

This idea originated on the Erie in June, 1908, when it was decided to establish courses, not with the object in view to make mechanical engineers out of shop workmen, but to inaugurate an apprentice system to train its students to competency and skill in the mechanic arts, and also to interest in business, loyalty to the railroad, and familiarity with Erie standards and methods.

When the schools are open, between September 30 and June 1, the apprentices are required to attend the classes four hours per week; two hours on each of two different days during working hours, and for this time they are paid as though on the regular hourly shop rate. Instruction covers the fundamental rules of arithmetic, common and decimal fractions, proportion, simple problems in interest, tables and weights; the elementary principles of plain and solid geometry, mechanical drawing, practical and theoretical mechanics, and instructions in standard practices pertaining to the construction of cars and locomotives, as well as lessons in their successful and economical administration.

There is no doubt regarding the fact that the apprentices of the Erie fully appreciate their opportunity to receive a free technical education, one which supplemented as it is by daily practical experience in modern shops equipped with up-to-date tools, is really more valuable to them than a technical school or college could afford. Fifty-one young men have already completed the course and received certificates, and as an instance of loyalty to their alma mater it may be mentioned that all but three are now in the Erie employ as skilled mechanics.

French Railway to be Electrified.—The electrification of existing steam railways is being pursued with activity in France. One of the latest electrifications is that which the Midi Railway of France will make in connection with the Montrejeau-Pau portion of the Toulouse-Bayonne line. The portion to be electrified has a length of some 70 miles; the country is very hilly and the line has a number of steep gradients, one of 3½ per cent. being above seven miles in length. This is the largest scale upon which electrification of existing lines has been attempted in France, and the results will be watched throughout Europe with no little interest. Later the electrification is to be extended to the entire Toulouse-Bayonne line, a distance of 200 miles.

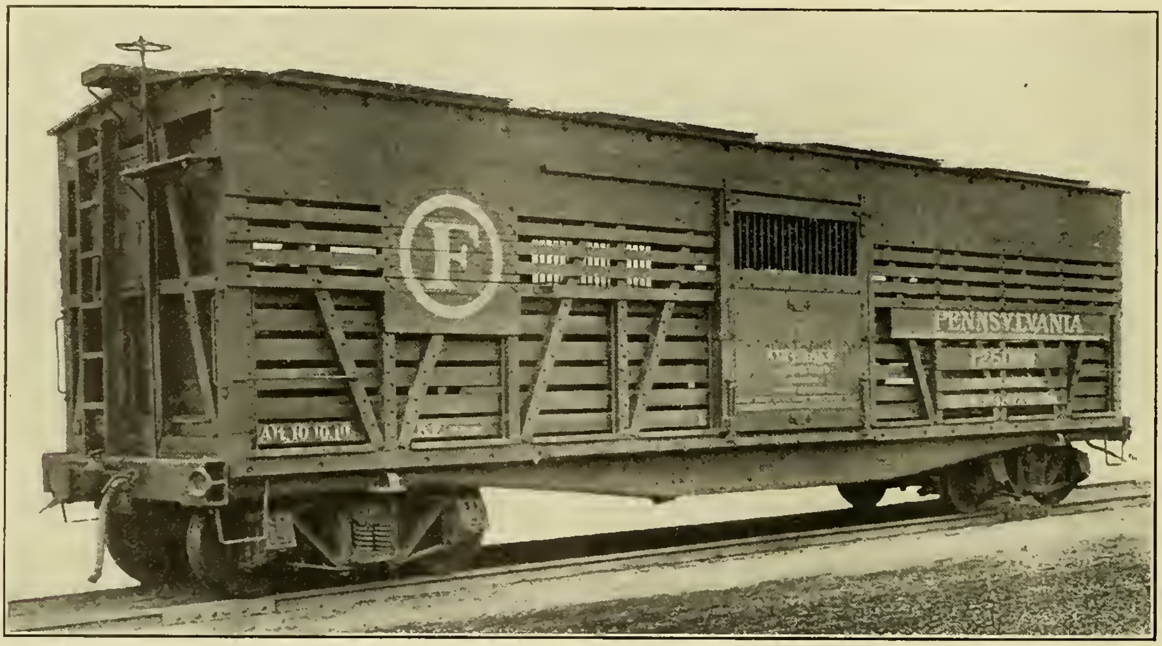
Telephone Train Dispatching.—G. K. Heyer, telephone engineer of the Western Electric Company, is authority for the statement that fifty-one railroads in the country, having a mileage of 35,000, are now using the telephone for train dispatching. The telephone is rapidly replacing the telegraph, and a number of the larger systems are making tests on their important divisions.

Bronze for Bearings.—In a series of tests conducted by Italian engineers it was found that bronzes high in tin were too hard for use as bearings and that only those containing 10 per cent. or less were suitable.

NEW LIVE STOCK CAR

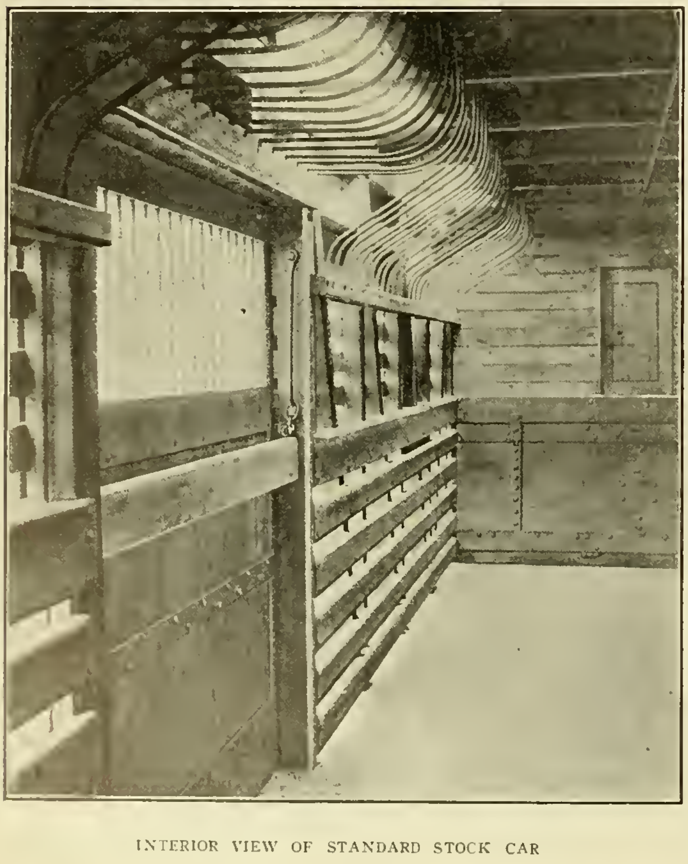
PENNSYLVANIA RAILROAD.

After devoting years to the development of the most suitable design for a standard stock car, the Pennsylvania railroad, in its class "KF," appears to have solved the problem with one which, while answering all service requirements, at the same time embodies many additional safeguards for the protection of the stock.



STANDARD STEEL UNDERFRAME STOCK CAR

This feature is particularly prominent in connection with the interior construction. All bolt heads and nuts on the inside have been rounded or countersunk, and all edges on side doors and interior walls with which the stock may come in contact have been rounded or chamfered. The floor is rough, in order to afford a firm foothold for animals, and being of oak on a steel underframe the possibility of sagging is eliminated, a feature when present which has resulted in many accidents to stock in transit though falling with the jerk of the train.



INTERIOR VIEW OF STANDARD STOCK CAR

Hay racks within the car extend from end to end, thus permitting feeding in transit, and the car has end sliding doors and handholds on bottom of carlins in order that attendants may enter. The roof of the standard stock car is of two ply thickness, and the upper portion of the hay racks and the ends of the car are boarded solidly to keep out all rain or snow. The trucks are fitted with graduated springs. The underframing, body, trucks and equipment follow the Pennsylvania railroad's specifications for 100,000 lbs. capacity cars with little variation. The general dimensions are as follows:

Length over end sills	38 ft. 6 in.
Length outside over body	36 ft. 11¾ in.
Length inside	35 ft. 11¼ in.
Width inside	8 ft. 5¼ in.
Width at eaves	9 ft. 10 in.
Height inside, floor to carlin, at side plate	8 ft. ¼ in.
Height from rail to floor	3 ft. 6¾ in.
Height from rail to running board	12 ft. 8⅝ in.
Height from rail to top of brake staff	13 ft. 2⅝ in.
Distance from center to center of trucks	28 ft. 6 in.
Wheel base of truck	5 ft. 6 in.
Centers of journals	6 ft. 5 in.
Size of journals	5½ in. x 10 in.

A model of this car was exhibited at Washington, D. C., October 10-15, on the occasion of the First International Humane Conference in America.

EFFICIENCY IN SHOP OPERATIONS.

It is generally conceded by managers of industrial as well as railroad shops and enterprises that high efficiency in equipment, in the methods employed, and also in the men, is one of the most desirable qualities to be attained. But the measure and development of efficiency and the remarkable results that must follow its cultivation have been clearly understood by but few. By those who are in a position to take a broad view of the situation it is clearly recognized that managements are generally realizing that the old methods are proving inadequate to present requirements, and that new ways are fast becoming a necessity.

This general subject was briefly discussed by H. F. Stimpson in a recent article in the *Iron Age*, and in commenting upon existing conditions he said:

"In the first place we must realize that the management of industrial enterprises is in a state of evolution. The tremendous growth of the past few years has caused certain previously satisfactory methods to become inadequate to present needs. Many details which in the days of smaller affairs could be absorbed by personal inspection and mentally stored for use when needed must now, because of their very volume, be made matters of record.

"The character of these records has much to do with their value. Because financial records are so ancient they have exerted an undue influence upon the character of all other records. While under our present civilization the ultimate object of industrial operations is to create financial profits, there are many highly important records which cannot be adequately expressed in terms of money. The business of manufacturing consists of a repetition of mechanical operations. Mechanical operations necessarily involve considerations of weight, distance, time and effort, but not of money.

"The reason for the failure of so many cost systems to serve the desired end is that they are based upon a wrong unit. These systems become useful only beyond a certain point. Other systems have been the result of a blind craving for aid, but being without broad underlying principles and not properly tied together and simply, in many cases, disjointed attempts to improve isolated details, they too have failed. The result is that attempts by specialists to improve industrial conditions have been often looked upon with suspicion and this is not altogether without reason. These very failures, however, have drawn the attention of men in certain lines of engineering to the rapidly developing needs of manufacturers. They have attempted to solve the problems by the use of engineering instead of by accounting methods, and the results which have been attained prove conclusively that a material advance has been made."

In view of this understanding of the present conditions and in discussing what efficiency really is, the old definition, "The ability to produce certain results," is employed, which at the very outset necessitates the existence or creation of a standard of measurement. And the author continues:

"This perception of efficiency, therefore, is correct only in proportion to the precision of the standard which must be accurately developed from data which are not only exact, but complete."

An example is given of a machinist, believed to be operating at very high efficiency, who was observed while turning a large shaft. His cut, feed and speed were beyond criticism, but when the shaft was finished he had to spend half as much time in hunting up a chain and pad to remove it from the lathe as he had taken for turning it. This reduced his actual efficiency from 100 per cent. down to 87 per cent., yet the man was not at fault, as his normal work was to operate a lathe and not to hunt for things which should have been provided for him. The points to be observed here are not only the importance of a standard of measurement, but that the efficiency of a mechanic depends largely upon his surrounding conditions over which he has no control, and which in turn depend mostly upon the efficiency of the management in securing the proper equipment. Finally this ability of the management in securing equipment depends to a great extent upon the efficiency of the records in showing clearly what increase in output and consequently in profits will result from improving the conditions, thus justifying the required expenditure. From this it is to be seen that the true standard consists of not the possibilities under existing condiions, but the possibilities under other and more desirable conditions.

The opposition offered to progress in this respect by managers in general, immediately controlling the records and conditions, but who should be the prime source of efforts towards increased efficiency, is exceedingly great, yet not altogether surprising, the author continues, for the following reasons:

"There is a widespread fallacy that so-called practical experience in the manual operations or technical processes of a business is the chief essential to success in its management. This is due to the fact that perfection of workmanship, of which he knows much, is more important in the eyes of the artisan than the actual cost of the operation, of which he knows little, or than the causes of this cost, of which he knows less."

The source of the highest degree of efficiency in a shop is unquestionably in the efficiency of its executive methods.

The necessity and value of a proper measurement of time, as a guide not only to the executive but to the workman as well, is most important, and the establishment of a correct standard, for this time measurement, although often very difficult, should be the first step in the attempt to increase the general efficiency. Every item of time can be divided into two parts: A standard or necessary time and a more or less preventable waste which later is the easier of the two to determine with a little careful study.

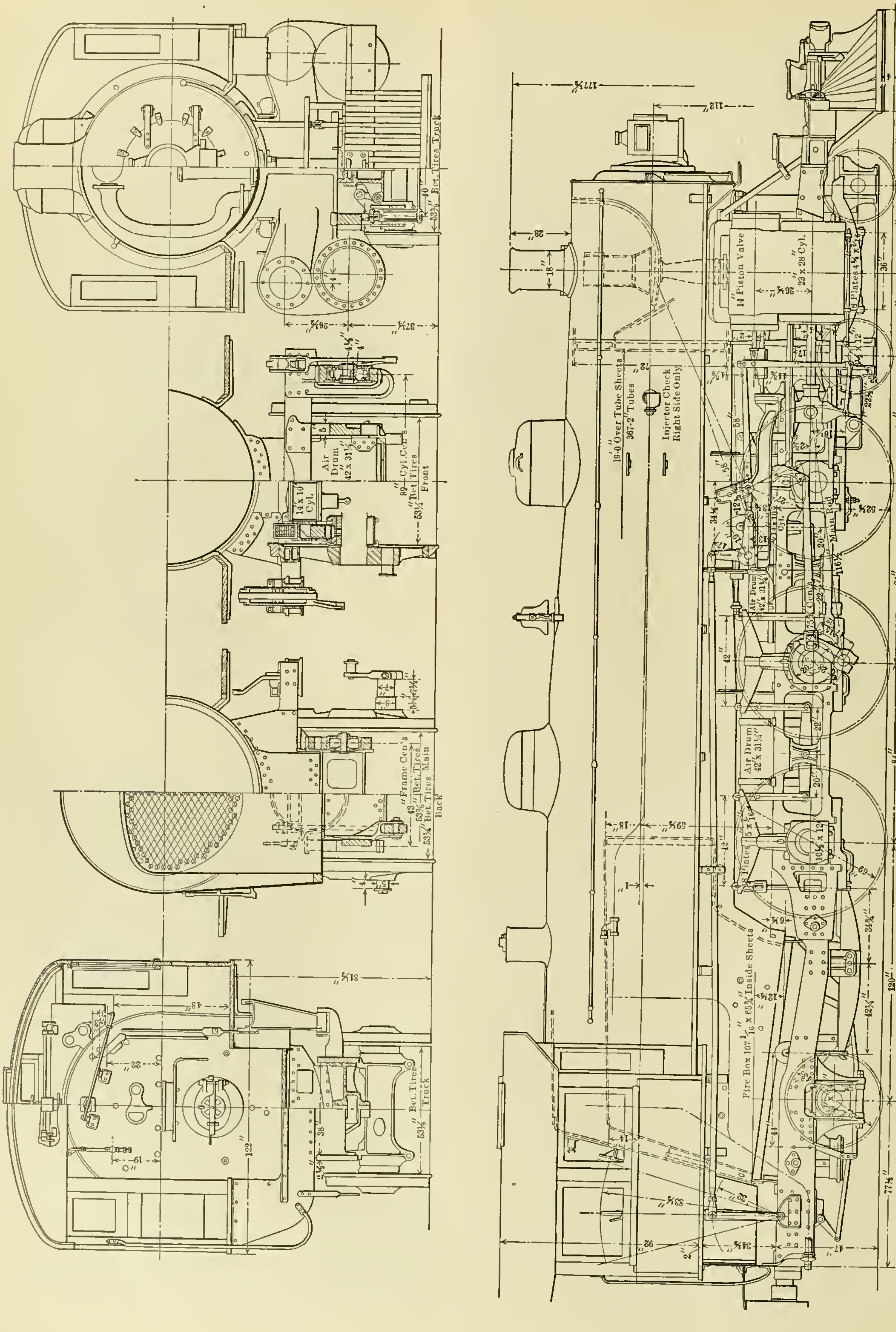
In regard to the bonus system as a means of increasing efficiency Mr. Stimpson says:

"The principal merit of this motive lies in the fact that immediate personal gain is the strongest incentive to immediate personal effort. It operates just as strongly on the employee as on the employer. Hope of promotion is too vague and the actual chances too limited to exert much pressure, but an extra sum in the pay envelope—or better still, in a separate one—for the disposal of the "old man himself," will do wonders. To be most effectual a bonus must begin not at the point of standard efficiency, but at the point when average efficiency ceases and extra effort begins; and it should increase on a curve faster and faster as the point of standard efficiency is neared, because the accompanying effort will be correspondingly greater."

The same efficiency methods can and should be applied from foreman up to and including the highest official. Under ordinary circumstances, the workman in need of material, tools, or instruction, is content to depend largely upon the foreman, because he reasons this is his duty, as he himself is not paid for these things, but with the proper bonus system and on standard time he makes vigorous demands to the foreman when anything is wanting to enable him to do his best work. The foreman does not resent this—as would ordinarily be the case—for his efficiency is determined by the combined efficiency of his men upon which also his own bonus depends. In this way all defects which were previously hidden from the superintendent are now brought to his attention and he welcomes them for the same reasons that actuated the foreman, all this resulting in hearty co-operation of foremen and workmen and a high general efficiency.

The value of fully planning the apportionment of productive time by a special department before incurring any operating expenses cannot be too strongly emphasized, because in apportioning the different parts of the product, this value has long been well understood by engineers and designers. It is possible, but only to one trained in the particular art, to schedule the different operations on all the parts of the product, and to combine these time studies on a chart which will show the disposition to be made of all men and machinery, thus giving the superintendent and foremen the advantage of the same predisposition of time that they now have of material. In this way the foremen are enabled to order material in time and intelligently, thus not only simplifying the work of the shop transportation department, but also aiding the purchasing department, and finally enabling the sales department to make delivery promises which mean something.

As a result of a number of close investigations, the facts show that the inefficiency in manufacturing which exists more or less generally, in spite of the prevailing impression to the contrary, is only about one-fourth due to the things over which the employees have control and three-fourths to conditions imposed upon them by the management. So-called welfare work is a highly creditable and necessary line of effort in removing obstacles and producing cheerful conditions for the workman, but some incentive is necessary in addition to induce him to make the best possible use of the facilities when they are provided. Successful efficiency methods to provide this incentive, however, can be developed and installed only by one trained in this direction who has previously made a careful study of existing conditions. But after being actually put in operation, they may gradually be relinquished into the control of those who have been educated in the process of installation with some hope of success for their future operation and for the maintenance of the resulting increased efficiency.



GENERAL ELEVATION AND SECTIONS OF 4-6-2 TYPE LOCOMOTIVE, BUILT AT THE WEST MILWAUKEE SHOPS OF THE C. M. & ST. P. RY.

Pacific and Consolidation Type Locomotives

SOME VERY POWERFUL FREIGHT AND PASSENGER LOCOMOTIVES DESIGNED IN THE OFFICE OF THE MECHANICAL ENGINEER OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY AND BUILT IN THE WEST MILWAUKEE SHOPS OF THE COMPANY

It has long been the custom of the motive power department of the Chicago, Milwaukee & St. Paul Railway to design many of its own locomotives. The latest examples of this practice, consisting of a new Pacific type and a consolidation type, are being built in the West Milwaukee shops of the company and are, therefore, throughout, a home production. To J. F. DeVoy, former mechanical engineer, now assistant superintendent of motive power, is due the principal credit for the work of designing. An inspection of the photographs and drawings given herewith show the particularly attractive appearance of both types and also indicate the remarkable simplicity and ruggedness that characterizes the arrangement throughout.

A careful study of the dimensions will show that while it has been clearly recognized that boiler capacity is the governing feature in any locomotive, particularly those in passenger service, these engines are well balanced between the boiler and cylinder capacity. The total number of square feet of heating surface divided by the volume of cylinders is in the case of the 4-6-2 type, 290.49 somewhat below other designs on our records, carrying the same steam pressure, but still not unusually low. It is also to be remembered that this balance has been decided upon in view of the experience gained by designing several other examples of this same type, which have been in service for some time. It should also be noted in this connection that the passenger boiler includes a combustion chamber 3 ft. long, having 53 sq. ft. of heating surface, which, while it largely reduces the total heating surface that would be given if the same space was filled with tubes, is probably equally valuable for evaporation.

In the freight locomotive the heating surface to volume of cylinders is about 234, being in about the same relation to customary ratio as is the one on the passenger design. This boiler, however, does not have a combustion chamber, and its comparative small heating surface is due to the short length of tubes, these being but 14 ft. 6 in. over tube sheets.

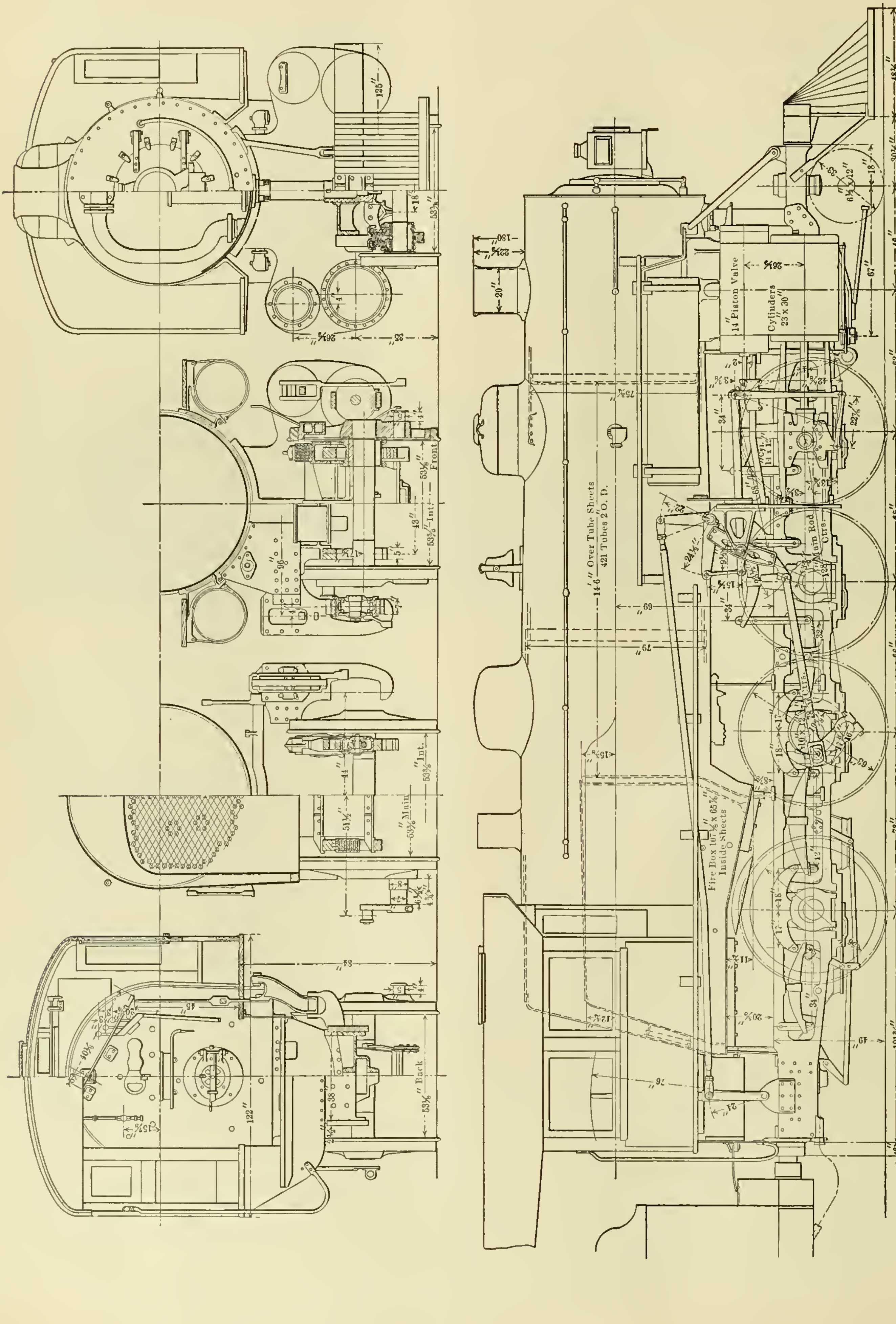
Considering first the passenger locomotives. While these are designed for service at various points throughout the whole system, including the coast lines, probably their heaviest duty is represented by the service between Chicago and Milwaukee, a distance of 85 miles, in which the maximum grade is .6 of one per cent. The time in this service is two hours and ten minutes, including a number of stops and slow speeds. Trains on this division sometimes run as high as 18 parlor and chair cars.

In view of this service, it is interesting to investigate the design for capacity. Assuming an evaporation of 12 lbs. of water per square foot of heating surface per hour, the boilers will furnish 46,920 lbs. of steam per hour. If the steam consumption per indicated horse power is 25 lbs. the locomotive will deliver 1877 horse power. At 50 miles per hour on a straight, level track the horse power required per ton is 1.79, which gives a total tonnage that the locomotive can handle under these conditions at this speed, of 1042, including the weight of the locomotive itself. It can therefore handle about 900 tons behind the tender. This would be about 18 cars of the average weight of chair and parlor cars, showing that it will be able to maintain this speed with the train required on a level track. Since the average speed for the total distance is less than 40 miles per hour, it apparently is well suited for this particular service.

In connection with the boiler of this locomotive it is interesting to note that the experimental locomotive of the same type,* put into service by this company about five years ago, and equipped with a long, narrow firebox which attracted considerable attention at that time, has apparently not proved to be the success anticipated. That locomotive had 23 by 26 in. cylinders and carried 200 lbs. steam pressure, the wheels being 72 in. in diameter. The ratio between the grate area and total heating surface was 94.5. In the present design with the same diameter of cylinders and 2 in. greater stroke, same steam pressure, and wheels 3 in. less in diameter, the total heating surface has been increased over 15½ per cent., and the grate area 36½ per cent., the ratio of the two now standing at 80.12, which is well above the average for this type of locomotive. In considering this feature, however, it should be remembered that the grate area and all ratios concerned with it are dependent upon the quality of fuel that is being burned, and while the narrow firebox locomotive was designed for a particular service in a particular section and was reported to satisfactorily fill the requirements, the present locomotives are intended to be widely distributed, a number of them running in a district where semi-bituminous coal will have to be used. Investigating this feature on the basis of the B. D. factor (tractive effort multiplied by diameter of drivers divided by total heating surface) and comparing it with locomotives designed for use on roads in the same vicinity, and of about the same size, it will be found that when allowance is made for the effect of the size of drivers on the tractive effort it represents about the average of what is considered good practice for that region. The 22 by 28 in. Pacific type on the Burlington with 74 in. drivers has a B. D. factor of 605. A 23 by 28 in. on the Alton, with 80 in. drivers, gives 618. A 23 by 28 in. with 75 inch wheels on the Northwestern has a factor of 548. A balanced compound on the Northern Pacific with 220 lbs. pressure, 69 in. wheels, gives a factor of 720, and the same ratio for the locomotive built about five years ago, mentioned above, is about 690.

POWERFUL PASSENGER LOCOMOTIVE DESIGNED AND BUILT BY THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY

* See American Engineer, March 19, 1905, page 74.



GENERAL ELEVATION AND SECTIONS OF 2-8-0 TYPE LOCOMOTIVE. A LARGE NUMBER OF THIS DESIGN ARE BEING BUILT AT THE WEST MILWAUKEE SHOPS OF THE C. M. & ST. P. RY.

A radial stayed conical type boiler is employed very similar to the design used on the same type locomotive in use on the Northern Pacific Railway.* The principal difference is in the length of the flues, which in this case are 19 ft. in place of 16 ft. 9 in. A liberal depth of throat is provided, the bottom of the mud ring being 25½ in. below the barrel. The side water legs are 4 in. in width and the inside firebox sheet is vertical, while the outside sheet has a decided inclination outward, the width of the water leg at the turn of the crown being 6¾ in. The combustion chamber is stayed by staybolts instead of plates and the firebox has four 3 in. arch tubes.

Reference to the illustration showing the general elevation and cross section will make clear all other features of the design and the general dimensions are given in the table at the end of the article.

Investigating the design of the freight locomotives on the same basis as used above in the passenger engines, and assuming an evaporation of 12 lbs. of water per square foot of heating surface per hour and a steam consumption of 30 lbs. of steam per h. p., at 10 miles per hour, it is indicated that this locomotive will be able to handle about 3,000 tons behind the tender up a .6 per cent. grade at a speed of 10 miles an hour. Since the tonnage trains between Chicago and Milwaukee are rated at about 2,600 tons and the average speed to be maintained is little more than 10 miles per hour, it is evident that this engine in that service will have a reserved capacity. An inspection of the various ratios indicate that it is well within the point of what is generally considered good practice for locomotives in this service.

HEAVY CONSOLIDATION TYPE LOCOMOTIVE DESIGNED AND BUILT BY THE C. M. & ST. P. RY.

There is nothing particularly unusual or novel in the general design, the features of which are clearly shown in the illustration.

It is planned to build 70 of the passenger locomotives, which are known as class F-3 and 75 of the consolidation engines, class C-2, at the Milwaukee shops. A number of these have already been turned out and are in service. The indications are that both classes are more than capable of filling the specifications. The general dimensions and other information are given in the following table:

GENERAL DATA.		
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Service	Passenger	Freight
Fuel	Bit. Coal	Bit. Coal
Tractive effort	36,500 lbs.	42,800 lbs.
Weight in working order	248,800 lbs.	215,700 lbs.
Weight on drivers	160,100 lbs.	189,200 lbs.
Weight on leading truck	46,000 lbs.	26,500 lbs.
Weight on trailing truck	42,700 lbs.	——
Weight of engine and tender in working order	383,350 lbs.	350,250 lbs.
Wheel base, driving	14 ft.	17 ft. 6 in.
Wheel base, total	35 ft. 7 in	26 ft. 7 in.
Wheel base, engine and tender	67 ft. 1¾ in.	60 ft. 2 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.39	4.42
Total weight ÷ tractive effort	6.82	5.04
Tractive effort × diam. drivers ÷ heating surface	641.56	800.30
Total heating surface ÷ grate area	80.12	69.04
Firebox heating surface ÷ total heating surface, %	4.58	6.37
Weight on drivers ÷ total heating surface	40,95	56.16
Total weight ÷ total heating surface	40.95	64.02
Volume both cylinders, cu. ft	13.46	14.40
Total heating surface ÷ vol. cylinders	290.49	233.97
Grate area ÷ vol. cylinders	3.62	3.38
CYLINDERS.		
Kind	Simple	Simple
Diameter and stroke	23 x 28	23 x 30
VALVES.		
Kind	Piston	Piston
Diameter	14 in.	14 in.
Greatest travel	6 in.	6¼ in.
Outside lap	1 in.	1 in.
Inside clearance	⅛ in.	0 in.
Lead	¼ in.	¼ in.
WHEELS.		
Driving, diameter over tires	69 in.	63 in.
Driving journals, main, diam. and length	10½ x 12 in.	10 x 12 in.
Driving journals, others, diam. and length	10½ x 12 in.	9½ x 12 in.
Engine truck wheels, diameter	36 in.	33 in.
Engine truck, journals	6½ x 12 in.	6½ x 12 in.
Trailing truck wheels, diameter	43 in.	——
Trailing truck, journals	8½ x 14 in.	——
BOILER.		
Style	Straight	Straight
Working pressure	200 lbs.	200 lbs.
Outside diameter of first ring	72 in.	75¾ in.
Firebox, length and width	107 1/16 x 65¼ in.	107⅛ x 65⅞ in.
Firebox plates, thickness	⅜ in.	⅜ & 5/16 in.
Firebox, water space	F. 4½, S. & B. 4 in.	F. 4½ in. S. & B. 4 in.
Tubes, number and outside diameter	369—2 in.	421—2 in.
Tubes, length	19 ft.	14 ft. 6 in.
Heating surface, tubes	3,651 sq. ft.	3,173.5 sq. ft.
Heating surface, firebox	206 sq. ft.	195.7 sq. ft.
Heating surface, comb. cham	53 sq. ft.	——
Heating surface, total	3,910 sq. ft.	3,369.2 sq. ft.
Grate area	48.8 sq. ft.	48,8 sq. ft.
Smokestack, height above rail	14 ft. 9½ in.	15 ft.
Center of boiler above rail	9 ft. 4 in.	9 ft. 10 in.
TENDER.		
Tank	Waterbottom	Waterbottom
Weight	134,550 lbs.	134,550 lbs.
Wheels, diameter	38 in.	33 in.
Journals, diameter and length	5½ x 10 in.	5½ x 10 in.
Water capacity	7,000 gals.	7,000 gals.
Coal capacity	10 tons	10 tons

* See AMERICAN ENGINEER, October, 1906, page 394.

WESTINGHOUSE EXHIBIT AT THE ELECTRIC RAILWAY CONVENTIONS

The exhibit of the Westinghouse Companies in connection with the Convention of the American Street and Interurban Railway Associations, at Atlantic City, was in their usual location in the main building, and was particularly conspicuous on account of the complete and varied nature of the operating machinery displayed.

A feature of great interest to those in attendance, and which attracted much attention, was the principal exhibit by the Westinghouse Traction Brake Company of a rack representing the complete equipment of a 10-car subway or elevated train of motor and trailer cars, which was most effectively arranged to clearly portray the operation of the latest electro-pneumatic brake system. Another demonstration equipment represented the complete arrangement of brake details on a five car train fitted with the company's type "A M M" automatic equipment for interurban service.

The Westinghouse Electric and Manufacturing Company had on exhibition a complete working outfit of its new type "H L" multiple unit control for street and interurban lines. The exhibit also included the standard railway motors manufactured by the company, motors for shop machinery, transformers and incandescent lamps. The Westinghouse Machine Company and the Westinghouse Lamp Company displayed their products with equal attractiveness.

HOT WATER BOILER WASHING AND FILLING SYSTEM

The use of hot water for washing and filling locomotive boilers meets with general approval in this country, and to perform this operation with economy and dispatch has resulted in the production of various boiler washing systems, both by the manufacturing firms and the railroads themselves. While these differ considerably in their individual development, the basic principle remains practically the same, and all designs exhibit a praiseworthy effort to avoid complexity and the multiplicity of parts.

One of the most recent of these systems is that of the Cowles-MacDowell Engineering Company. It is a plant practically automatic in operation, and constitutes a continuous feed water heating system, one whose efficiency can be greatly increased through arrangements in the roundhouse which will permit the operations to be practically continuous, and with as few intervals of rest as possible. The accompanying diagram clearly illustrates the working of the system and its usual application to roundhouses.

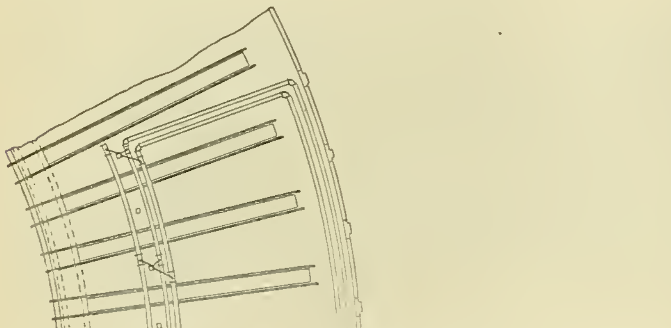
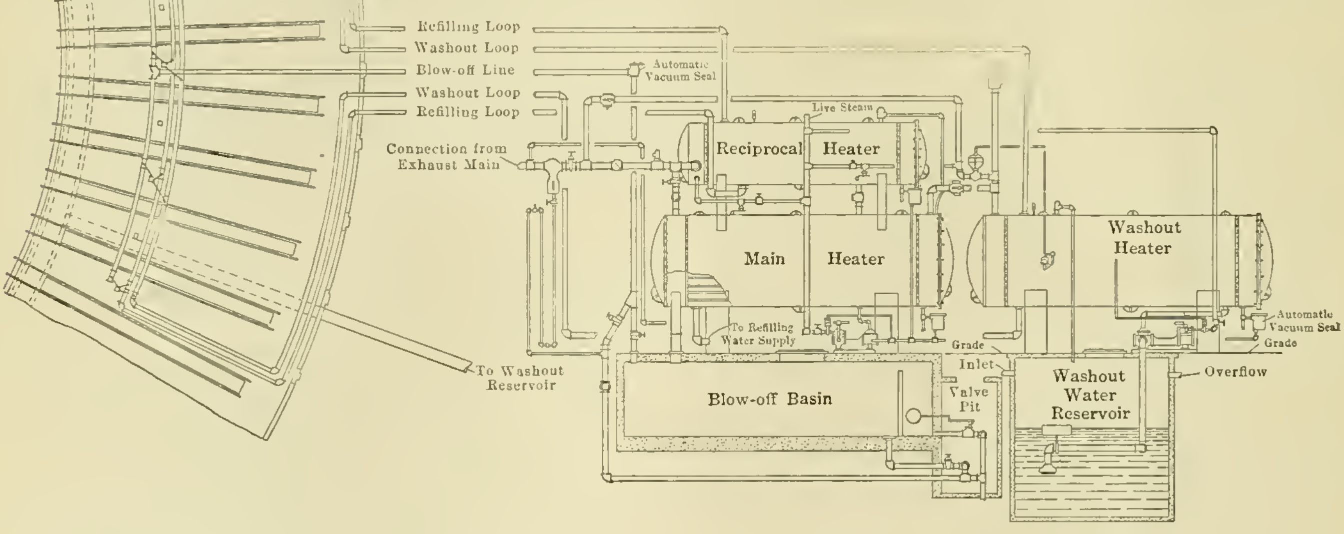



DIAGRAM SHOWING PARTS AND CONNECTIONS OF THE COWLES-MACDOWELL SYSTEM OF HOT WATER BOILER WASHING AND FILLING

Blow-off water and steam is delivered first into the concrete blow-off basin, which with all the heaters is under 9 in. vacuum, except when engines are blowing off. The hot vapor only of the blow-off water and steam is passed through the tubes into the main refilling and washout heaters. The heat is practically all extracted from the blow-off water, and the dirty water and sludge are left in the blow-off basin to be passed to the sewer. Such of the hot vapor as may condense in the tubes of the main heater passes through a vacuum trap to the suction of the vacuum pump, and is then discharged into the main heater through a receiver and automatic pump where it adds to the heat and quantity of the refilling supply. Surplus blow-off steam is passed to the washout heater as later described.

Water from the general water supply,—or treated water if such is used—is delivered into the bottom of the main heater between the tube sheets, under pressure from the general service pump, or from the city lines, or reservoir, as may be the case. In the first or main heater clean water is raised in temperature by its absorbing the heat from the blow-off, and it then passes into the reciprocal heater above the main heater where its temperature is raised to 180 deg. or higher, by its absorbing the heat from the exhaust or live steam, both of which circulate through the tubes in the heater. From this heater the refilling water passes to the roundhouse through a 3 in. or 4 in. main that returns full size to the reciprocal heater, the water entering again between the tube sheets and circulating around same as in the first instance. Efficient circulation is secured by the large pipe, constituting with the heater a circulating loop as shown on the drawing. Condensed steam in the reciprocal heater passes through a vacuum trap to the suction of the vacuum pump and then into the main heater, in the same manner as the condensation in the main heater.

Exhaust steam is first passed through an oil separator to an end chamber of the reciprocal heater, and then through the tubes of this heater. Live steam enters the same end of the reciprocal heater as does the exhaust steam, and circulates through the tubes. There is a reducing valve on the live steam line, set at about 1½ lbs., and the amount of live steam condensed is relative to the temperature of the refilling water in the reciprocal heater. The latter contains a thermometer and water relief valve. The thermometer giving the temperature of the refilling water, and the water relief valve is set relative to the pressure of the refilling water.

Hot water is supplied through the washout heater which is supplied with a thermostat set at about 130 deg., and is either air or water operated. A spring opened diaphragm thermostat valve is set in the line entering an end chamber of the washout heater, and is normally open, but is closed under action of the thermostat when the temperature of the washout water exceeds 130 deg. All waste water from the roundhouse, except that from toilet room, and including washout, waste spigot water, and down spout water, is drained to a large concrete reservoir near the heater house, where it is used for washout purposes only, thus conserving considerable water.

The washout pump takes its suction from this reservoir and passes it through the washout heater, where its temperature is raised as above described. The washout water then passes to the roundhouse through a 3 in. or 4 in. main that returns full size to the bottom of the washout heater between the tube sheets, permitting the water to again circulate around the tubes as in the first instance, thus ensuring efficient circulation. The condensed blow-off, exhaust, or live steam is passed through a vacuum trap to the suction of the vacuum pump, and then through the receiver and pump into the main heater, where it adds to the supply and temperature of the refilling water.

Exhaust steam from all pumps is discharged into the main exhaust steam line outside of the oil separator, and the pumps are controlled by governors in the usual way. A vent pipe with a back pressure valve set at about 5 lbs. leads to the atmosphere from the end chambers of the washout heaters which constitute the main relief. Check and cut-out valves are set at the proper places and for the usual purposes. The heaters are built to pass Hartford Boiler Inspection. The washout and refilling lines are not cross connected in the roundhouse, consequently the washout gang cannot tamper with water, but must use same just as it is received from the heaters. Hot feed water can be supplied to stationary boilers from the refilling main and thus save the cost of feed water heaters; pumps, and installation of same, or giving the economy of hot feed water where cold water may now be used. The blast coils of a fan system, or the coils of any steamheating system, can be connected up with the vacuum pump of the washout plant, and thus insure efficiency and economy.

Where the saving of water is of importance all the waste or washout water can be used, heated to and delivered at the washing-out point at any desired temperature, and the blow-off and exhaust steam automatically diverted from the fresh water heaters to the washout heaters and vice versa for this purpose. Thus the steam is usel to heat the water first needed and then automatically diverted to the next to be used. Insuring water at the desired temperatures at all times for the different purposes, and these temperatures maintained at the delivery points, as in the washout water it is very essential that the first water entering the hot boiler being washed out should be at the desired temperature to prevent the rapid contraction of plates, staybolts, etc. Automatic diversion of heat is an important function and is found to be well provided for in this system.

HOLLOW CHISEL MORTISER FOR WIDE RANGE OF HEAVY WORK

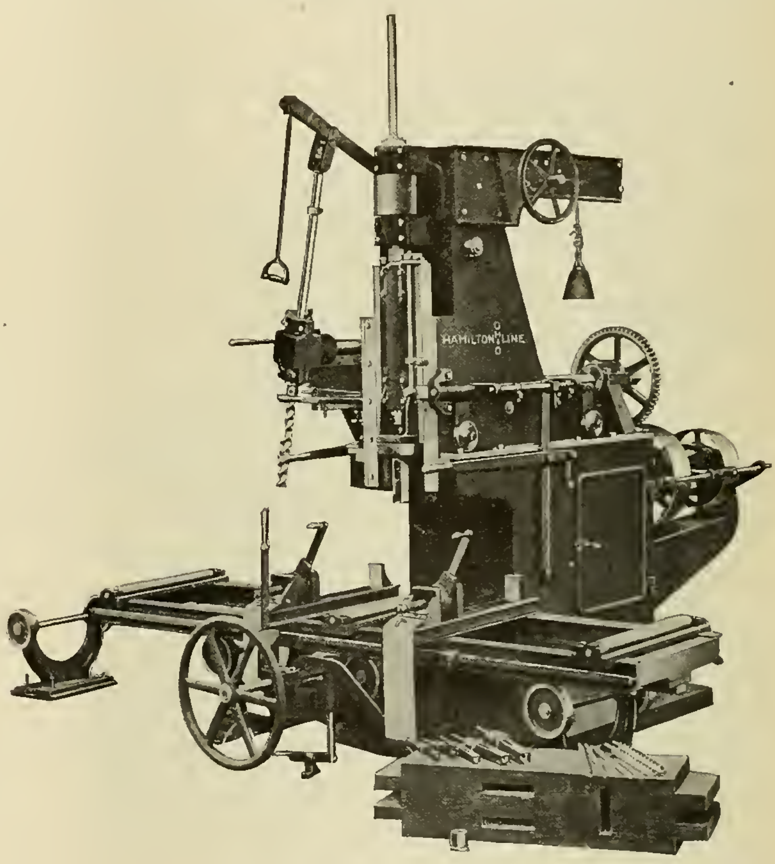
This powerful machine has been especially designed by the Bentel-Margechant Co. for the heaviest line of mortising, taking chisels up 2½ in. square. It thus embodies an extremely wide range, being equally adapted for railroad and car shops, navy and ship yards, etc., and is built with a traveling carriage from 10 to 40 feet in length.

The illustration clearly indicates the unusual strength of the design as a whole. The frame is a single cored casting, with a wide base and solid support for the table. It carries the large housing on its top in square gibbed slides, supporting it by four rollers which run on the top surface of the gib. This movement is made with unusual ease through rack and pinion feed, controlled from the operator's position by a ratchet lever. The housing without counterbalance works in either direction.

It will be noted that the table is of very rigid steel beam construction to carry the heaviest timbers, and is mounted on large roller ways at even intervals. It has both power and hand feed; is provided with quick acting eccentric clamp, and will clamp material 20 in. wide by 16 in. The feature of adjustable stops along the front make provision to gauge accurately to length, and this is under full control of the operator through the power lever or hand wheels. The table can be stopped or started instantly.

Probably the greatest interest in the study of this machine centers in the actual mortising mechanism. The chisel ram, 29 in. long, mounted on the front of the housing in dovetail slides, is counterbalanced to take all weight from the working mechanism. The long, closed cap box holds the boring chisel rigid for running the latter at high speed without vibration, the driving pulley being carried between two boxes and sleeved in the same full length. The spindle sliding in sleeve prevents wear ot boxes, and retains alignment against the heavy pull of the belt. The latter is controlled on the pulley by two idlers, one being automatically adjustable to take up variation in the belt length or position, owing to the belt being crossed as it comes from the countershaft above.

The chisel ram has 17 in. vertical movement and 16 in. transversely across the carriage, mortising 6 in. deep. The power is imparted by a train of gearing and reverse friction pulleys—all placed outside for ready inspection, adjustment, etc. The cutting speed of the chisel is 13 feet per minute, with return double this speed. The radial boring attachment can be used either on one side, as shown, on both sides, or may be omitted. It has 20 in. vertical adjustment, 16 in. transverse adjustment, and an angular adjustment of 30 degrees either way.



HOLLOW CHISEL MORTISER FOR HEAVY WORK

Prizes for Good Track.—With a view to maintaining a healthy rivalry among its track Supervisors and Assistant Supervisors, the Pennsylvania Railroad offers annually the sum of $5,400 in premiums to those whose divisions have been kept in the most perfect condition during the year. The premiums for 1910, six in number, were distributed recently at Harrisburg on the close of the first day of the General Manager's Thirty-Eighth Annual Track Inspection.

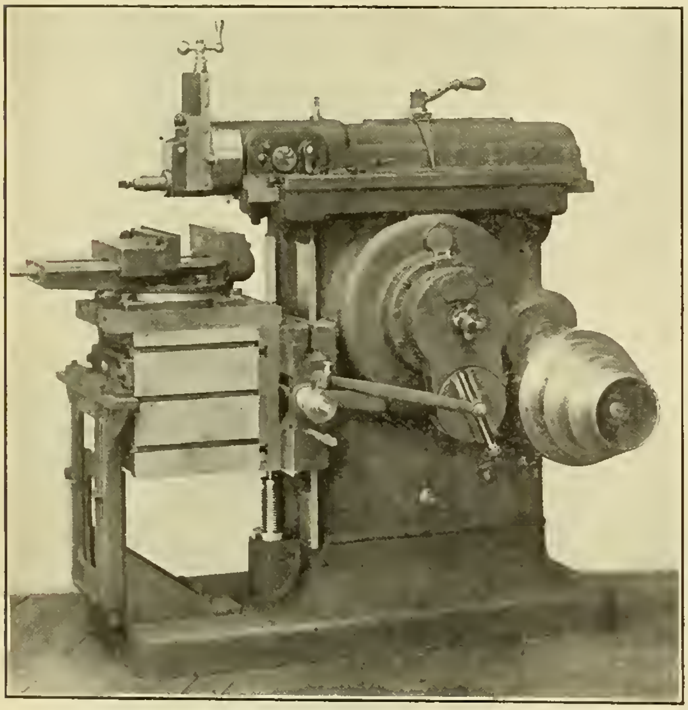
Coal Lost Through the Stack.—Prof. W. F. M. Goss, giving results of his test, estimates that of the 90,000,000 tons of coal consumed by the 51,000 locomotives in the United States in 1906, 720,000 tons were lost through incomplete combustion of the gases; 10,080,000 tons were lost through heat of gases discharged through the stack; 8,640,000 tons were lost through cinders and sparks, and 2,880,000 tons were lost through unconsumed fuel in the ashes. The figures indicate that there is considerable room for improvement in our present draft appliances.

Atlas Lead Cement.—A cement designed to take the place of lead for calking of pipe joints, etc., has recently been perfected. This cement is claimed to be twice as strong as lead and to cost about half as much. It sets without shrinkage and is remarkably simple to handle. Samples can be obtained from R. F. Lang, 31 Broadway, New York.

IMPROVED 16 INCH STOCKBRIDGE CRANK SHAPER

This 16 in. back geared shaper for toolroom work, or as a productive shop tool, has been designed with the idea of meeting all the requirements of up-to-date manufacturing, and to this end a heavy, rigid machine weighing 2,850 lbs., has been evolved. Besides the regular characteristics of Stockbridge Shapers, this machine embodies several new features designed to add materially to its productive capacity.

Among these is the column ways on which the cross rail slides. The method of attaching the cross rail to the column is new in shaper practice, though long employed in milling machine design. With this construction one gib is cast solid with the cross rail, which in addition to increased stiffness, prevents any possibility of the rail tipping away from the column when the adjusting gib, which is on the working side of shaper, is loosened. Through this construction no time is lost in going around machine to tighten and unloosen binder bolts every time the cross rail is lowered or raised, which is necessary where two loose gibs are used. By simply tightening the gib binder screws on the working side of shaper the cross rail is locked to the column, a similar construction to that of a milling machine.



AN INTERESTING 16-IN. CRANK SHAPER

It will be noted that the rocker arm is of special design. The slide ribs are cored "U" shape, making an exceptionally strong construction, and the slot in the rocker arm is of unusual depth and width to provide ample surface for the crank block. The ram is carried around on a semi-circle on the top and the sides are built straight down. This construction, together with internal ribbing, gives an unusually strong and stiff ram. The head, which is accurately graduated, and can be adjusted to any angle, is locked in place by two bolts, one on either side. For taking up the wear in the ram ways, tapered packings are provided, which run the entire length of column and are adjusted from either end by means of screws. The automatic cross feed is so constructed that there is no necessity of changing the position of the cross feed rod, when it is desired to reverse the direction The reversing is done by moving the block in the slide to one side or the other of the center, the slide having a reciprocating motion. Bar screw is fitted with graduated collar reading to .001 of an inch, and down feed to head either hand, or automatic, can be provided. The head slide has a graduated collar reading to .001 of an inch, which can always be set from zero without regard to position of screw.

From the dimensions given below it will be noted that this machine is particularly heavy and of unusual capacity for a 16 in. machine:

Actual length of stroke	16¾ in.
Vertical travel of table	14¾ in.
Horizontal travel of table	23 in.
Minimum distance of ram to table	2½ in.
Maximum distance from ram to table	17 in.
Poppit takes tool	⅝ in. x 1¼ in.
Takes shaft for keyseating	2¼ in.
Vise opens	12 in.
Size of vise jaws	12 in. x 2½ in.
Tight and loose pulleys on countershaft	14 in. x 3½ in.
Speed of countershaft for cast iron	300 revolutions
Fin. Wt. of machine	2,850 lbs.

A NEW BASIS FOR PURCHASING BELTING.

Believing that the subject of belting is one that is not ordinarily given sufficient attention in railroad shops, this journal has during the past eighteen months devoted many columns of space to discussing belting manufacture, specifications and proper application. We feel sure that a systematic and intelligent following up of this subject will result in a decided saving, not only in the cost of belting itself, but also in relief from the interruptions and inefficient machine tool operation that unsuitable belting so often causes in the ordinary shop.

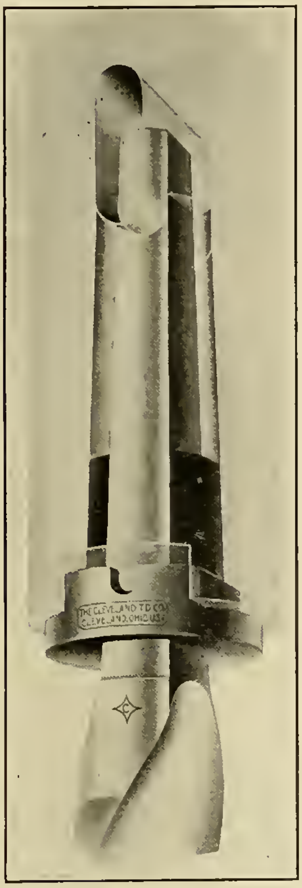
We are, therefore, pleased to announce that a new belting company has recently been organized and is preparing to distribute its product on a new basis. In the announcement of this company it is stated that it proposes to furnish belting which a careful study of all conditions shows to be suited to that particular work. The engineers of the company are to study the conditions and make the recommendations and then upon the basis of this report the company will guarantee that particular belt for that particular service for a specified length of time. Heretofore it has been the custom of manuafcturers to guarantee the fulfillment of certain specifications and qualities, which guarantee could only be checked by laboratory tests and there was no resource offered when the belt failed to perform its normal service if the tests showed it to fill the specifications. It is, of course, well known that a certain type of belt which is undoubtedly the best for one location or service is not by any means the best for others, and the engineering department of this new company proposes to study each individual application and to know which is the best belt for that purpose.

The firm issuing this announcement is the Olmstead-Flint Co., 136 Liberty St., New York.

STANDARD SOCKET DRIVE FOR FLAT TWIST DRILLS

The Cleveland Twist Drill Company, of Cleveland, O., has recently applied for patents on a device for driving flat taper shanks that are tapered both on the flat sides and round edges. Ordinarily these shanks, which are regularly furnished on this company's flat twist drills, are driven by sleeves or sockets internally equipped with flat taper holes coincident to that of the shanks, and externally tapered to fit standard taper sockets or spindles, but certain disadvantages are present in this arrangement, particularly in the case of large taper shanks, which cannot be adapted to the drill press spindles without the use of cumbersome reducing sockets. With the new device these latter are no longer necessary, and much additional driving strength is imparted.

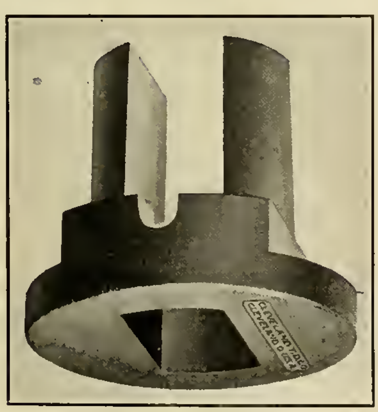
To this end both the No. 5 and No. 6 "Paragon" shanks have been re-designed the same length as regular taper shanks, the taper on the round edges being regular Morse taper, as formerly. When this modified shank is inserted directly in the spindle the upper end of the shank is received and driven by the flat slot in the spindle just as is the tang of an ordinary taper shank drill. This alone would constitute a strong and practical drive, but for the lack of support the shank would have on its two flat sides at the lower end of the spindle. To provide against the resultant possibilities of vibration and wear between the shank and spindle, and to furnish a powerful additional drive at the lower end of the shank where its cross sectional area is greatest,



COMBINATION OF NEW PARAGON COLLET WITH DRILL AND SPINDLE

a new and original type of socket, called the "Paragon" collet, has been evolved.

As herein illustrated, singly and in combination with the drill and spindle, the collet consists of two lugs projecting upward from a flattened disc through which is cut a rectangular hole to receive the shank. When the latter is applied it will be noted



THE NEW PARAGON COLLET

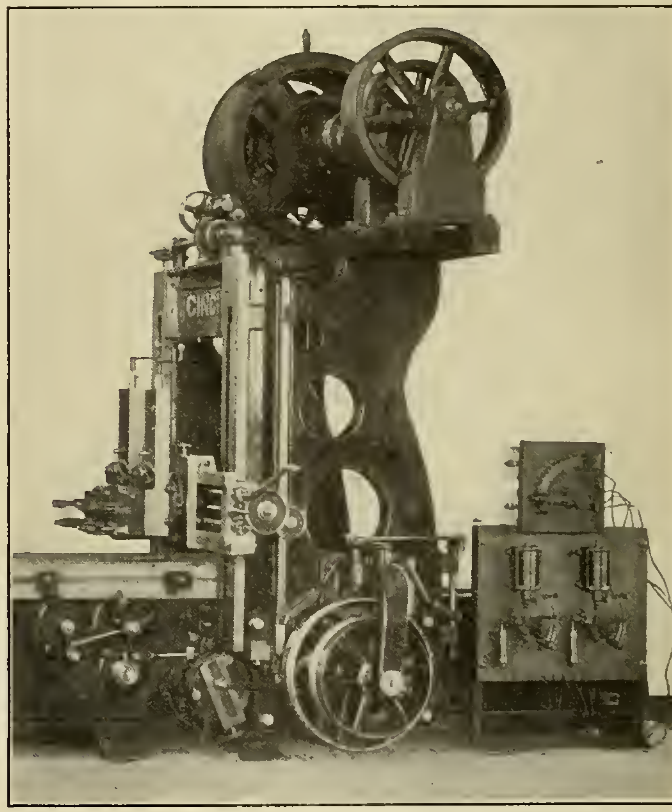
that the combination is practically an interchangeable taper shank with unusually long tang. The additional drive is protected by means of the extension, which is clearly shown projecting upward, in the case of vertical drilling, from the circular base of the collet. This projection mortises into a slot cut across the end of the spindle, conforming to the standard slots which several well-known manufacturers are now providing in the spindles of all heavy duty drill presses.

The collets are furnished without the extension, or mortise lugs, in instances where the spindles are not provided with slots, but it is of course understood that the additional driving strength will thereby be lost. That the tongue and groove drive at the large end of the shank is very much stronger than any drive on the tang could possibly be, is quite evident through a glance at the illustration, and it is also quite clear that a practically perfect drive is provided for in the instance of the larger sizes of flat twist drills.

A RECENT ELECTRIC VARIABLE SPEED DRIVE

A new electric speed controller, and its application to a 36 in. Cincinnati planer is clearly portrayed in the accompanying illustration. This consists of a motor drive arranged so that the operator can change the speed of the cut or return stroke to suit conditions. The motor is mounted on top of the planer, similar to a regular plain motor drive and is coupled direct to the countershaft, doing away with all gearing.

It is a two to one variable speed, controlled by the switch



APPLICATION OF ELECTRIC VARIABLE SPEED DRIVE TO 36 INCH PLANER

board located at the rear of the housings, on top of which is the usual starting box. On the large switch board are two controllers. One for the cutting stroke, by which any desirable speed can be obtained between 25 and 50 ft. without in any way altering the return, while the other controller is for the return speed, and this can be varied between 50 and 100 ft. without effecting the speed of the cut, so that it is possible to operate on a 40 ft. cut and a 60 ft. return, or a 20 ft. cut, with a 90 ft. return.

Immediately in front of the housing is a limit switch which operates these controlling levers, so that after they have been set for any particular speed, they will automatically return to that speed at each stroke. The wiring shown is only temporary, as this arrangement does not require any more than a regular drive, except that the wires must be run to the limit switch.

THE PENNSYLVANIA RAILROAD will shortly have available for use on its lines east and west of Pittsburg and Erie 1,988 solid steel passenger train cars. This includes some 600 Pullman parlor and sleeping cars, as well as a large number of suburban coaches such as the company's shops are just beginning to turn out.

The Railroad Clubs.

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Nov. 1	Recent Development in Signaling	A. H. Rudd	Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	Nov. 11			H. D. Vought	95 Liberty St, New York
New England	Nov. 8	Passenger Car Heating	Geo. E. Hulse	G. H. Frazier	10 Oliver St., Boston, Mass.
New York	Nov. 18	Railroad Relief Departments	J. N. Redfern	H. D. Vought	95 Liberty St., New York
Northern	Nov. 25			C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	Nov. 25			C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Nov. 14	Election of Officers and Annual Reports		F. O. Robinson	C. & O Ry., Richmond, Va.
Southern	Nov. 17	Firing Locomotives		A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	Nov. 11	[illegible]		B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Nov. 21			J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	Nov. 14	Electricity at Terminals	J. A. Douglass	W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

THE TESTING DEPARTMENT

NEW YORK RAILROAD CLUB

At the September meeting the paper presented for discussion was entitled "The Testing Department of a Railroad Company," prepared by B. S. Hinckley, engineer of tests of the New York, New Haven & Hartford Railroad.

In the paper Mr. Hinckley draws attention to the practical value of a first-class testing department and points out the manner in which it saves a large railroad company considerable sums of money each year. He then takes up the matter of systematically handling and recording the work in the department and presents a number of blank forms used to cover the procedure of inspection and reporting most of the lines of work covered by the department.

One of the statements in the paper which aroused some objection from a few of the members was: "The testing department should be independent of all mechanical or engineering departments, for the chief economical results are secured only by giving freedom to the department of tests in its work of checking the quality, handling and use of the materials purchased."

P. H. Dudley, consulting engineer of the New York Central & Hudson River Railroad, confined his discussion quite largely to the subject of rails, pointing out improvements in manufacture which had gradually taken place; drawing attention to the value of the testing department in this work. He stated that the work of all testing departments will enlarge, and that besides making examinations of the ordinary purchases they should undertake a large amount of research work upon the results of service tests.

Among others who discussed this paper were H. J. Force, chemist of the D., L. & W. Railroad; Robert Job, who agreed with Mr. Hinckley that the head of the test department should report directly to the general or executive officer of the company; George A. Post; Eugene Chamberlain; F. P. Cheesman and H. H. Maxfield.

At the October meeting of the Club a paper on "Protection of Metal Equipment" was presented by William Marshall, president of the Anglo-American Varnish Co.

This paper was confined almost exclusively to the painting of steel passenger cars and was made up of the answers received to a series of questions sent out to the master painters of the various railroads.

ANALYSIS—CHEMICAL AND OTHERWISE

CENTRAL RAILROAD CLUB

At the September meeting E. M. Tewkesbury presented a paper in which he analyzed a number of features of railroad operation and pointed out the value of chemical analysis for a large number of materials used by railroads, particularly steel rails and other metals.

He spoke very strongly in favor of a careful chemical analysis of coal, and drew attention to the savings which have been claimed as a result of good firing, which can be far exceeded if coal of the proper quality, as shown by chemical analysis, was obtained all of the time. All coal should be purchased on the basis of specification.

Analysis of paint was also considered. The results of analysis of the membership of the Central Railroad Club was given, showing how many representatives there were of each different position. The locomotive engineers lead with sixty-five members, followed by thirty-one general foremen of the car department and twenty-four general foremen of the locomotive department. There are sixteen general inspectors; eight road foremen of engines; eight superintendents of motive power; seven superintendents; three mechanical engineers and one draftsman. The membership also includes seventeen chief clerks; one master plumber; one surgeon; four storekeepers; one freight solicitor, one arbitrator, etc., etc.

The paper was discussed by J. P. Kelly; D. L. Tuttle; John Talty, and others.

UTILIZATION AND CHEMICAL APPLICATION OF A BI-PRODUCT

RICHMOND RAILROAD CLUB

Dr. James M. Whitfield presented a paper on the above subject at the regular September meeting of this club. He confined his remarks entirely to coal tar, pointing out the great variety and enormous value. This included a discussion of the value of tar for roads and the method of applying it. He also considered tar roofing, flooring and other uses of tar. There was no discussion.

THE SECTION FORCE IN RAILROADING

NORTHERN RAILROAD CLUB

At the meeting of September 24, L. S. Morphy, designing engineer, Boston & Albany Railroad, presented a paper on the above subject. It considered briefly the work of the section gang in maintenance of the roadbed and track.

NEW COMMERCE COURT

WESTERN RAILROAD CLUB

At the October meeting Paul Synnestvedt presented a paper on the subject of "Special Courts," especially discussing the new Commerce Court soon to be organized. Mr. Synnestvedt is fully conversant with the situation and gave the members a very pleasant and profitable evening.

IRON CASTINGS

CANADIAN RAILWAY CLUB

Robert Job, vice-president Milton Hersey Co., Ltd., presented a paper before the September meeting of the Canadian Railway Club entitled "Iron Castings, Defects and Remedies," in which he discussed the effect of the various components of cast iron, pointing out the features of each that are an advantage and wherein they become a disadvantage. He also discussed foundry practice in its various features and presented a number of lantern slides, showing reproduction of etchings on iron.

The paper was discussed by Mr. Best, of Ward & King, Ltd., and Mr. Watson.

At the October meeting the paper was by P. McLaren, machinery expert, Grand Trunk Railway, entitled "Some Thoughts on the Training of Apprentices."

BOOKS

Work, Wages and Profit. By H. L. Gantt. 5 x 7½. 199 pages. Published by the Engineering Magazine, 140 Nassau street. New York City. Price, $2.00.

"The ratio of what can be done to what is done is even greater than three to one in work requiring skill and planning. Well thought out plans alone if accompanied by complete instructions for doing work often produce an increase of more than 100 per cent. over what is usually done." In these words Mr. Gantt accurately states a condition which exists in practically every line of work throughout the whole country. This condition is one which not only benefits no one but actually is a decided detriment in any way it may be looked upon. It is a condition which should be a source of national shame, but luckily it is also one that can be remedied. In this book, which is positively fascinating to anyone interested in the subject, the author points out very clearly that this frightful inefficient condition of labor is not by any means the fault of the workman, who throughout has taken the most logical and natural course under the conditions existing, but it is very decidedly the fault of the managers. Luckily a great majority of these are capable of being educated, and Mr. Gantt, together with others like him, may have an opportunity of seeing their efforts rewarded by general improvement in the efficiency of labor throughout the country.

There is nothing intricate or difficult in the schemes proposed as a remedy, and in this book, which is a collection of papers and articles written by the author at various times, the basic principles of the proper scheme of progress are briefly but very clearly brought forward. The whole problem is summed up by the author as consisting of but three parts; first, to find out the proper day's task for a man suited to the work; second, to find out the compensation needed to enthuse such men to do a full day's work; third, to plan so that the workman may work continuously and efficiently. It is also pointed out by the author that the proper method of payment is really one of the minor parts of the whole problem. In solving this problem Mr. Gantt has evolved what he calls the "task work with a bonus" and states that the elements on which this system is founded are as follows: 1. A scientific investigation in detail of each piece of work and a determination of the best methods and shortest time in which the work can be done. 2. A teacher capable of teaching the best method in the shortest time. 3. Reward for both teacher and pupil when the latter is successful. In explanation of the practical working of the system recommended a number of real examples are shown and discussed.

This is one of the most important books of its kind published in years. It deals with a subject which is of interest and importance to the whole country and should be read by every man who is in any way responsible for workmen.

Poor's Manual of Railroads for 1910. Forty-third annual edition, 2,685 pages. Published by Poor's Railroad Manual Co., 68 William street, New York. Price, $10.00.

This number is devoted exclusively to statements of the railroads and street railways, the statements of industrial corporations having been incorporated in a separate book mentioned in the Sept. issue of this journal. The present manual appears in a new and attractive type, larger and more legible than that used in former editions, with a new feature consisting of a number of analytical tables, so constructed as to offer a test of the financial strength and the operating efficiency of every important system. These tables, which have never been presented in a reference work, will be found very valuable.

The total mileage of steam railroads on December 31, 1909, is reported as 238,356 miles, against 232,046 miles on December 31, 1908, showing an increase of 6,310 miles. The gross earnings of these roads for 1909 was reported as $2,513,212,763, showing an increase of $106,192,953 or 4.41 per cent., and the net earnings for 1909 were $852,153,280, an increase of 18.72 per cent. The capital stock was $8,030,680,963 for 1909, an increase of about $389,000,000 or 5.09 per cent. over that of the previous year. The funded debt was $9,118,103,813, an increase of only 3.75 per cent. The revenue per ton mile was 0.757 cent, as against 0.767 cent in 1908, and per passenger mile was 1.934 cents, as against 1,964 cents in 1908.

Twentieth Century Sheet Metal Worker. By H. E. Osborne. 86 pages, 5 x 7½. Illustrated. Published by the American Artisan, 355 Dearborn street, Chicago, Ill. Price, cloth, $1.00; paper, 60c.

Mr. Osborne is a practical sheet metal worker of many years experience, and has recognized the need of a popular priced pocket reference book of short cuts and quick methods, combined with accurate information for the tinner or sheet metal worker. He therefore in writing this book has eliminated all long winded scientific rules and explanations, and has given plain, straightforward, clean cut information in simple language, which, while it is suitable for the youngest apprentice, is equally valuable for practical use of the journeyman. The illustrations are large and well arranged and with all the book seems to be particularly well suited for the use intended.

PERSONALS

C. M. Stansbury has been appointed master mechanic of the Ocean Shore Ry., with office at San Francisco, Cal.

J. F. Farrell has been appointed purchasing agent of the Detroit & Charlevoix R. R., with office at Detroit, Mich.

J. E. Cameron has been appointed master mechanic of the Kentwood, Greensburg & Southwestern R. R. at Gulfport, Miss.

E. L. Burdick has been appointed assistant engineer of tests of the Atchison, Topeka & Santa Fe Ry., with office at Topeka, Kan.

E. D. Bronner has been appointed superintendent of motive power of the Detroit & Charlevoix R. R., with office at Detroit, Mich.

P. J. Hannifan has been appointed road foreman of engines of the Rochester division of the Erie Railroad, with office at Avon, N. Y.

S. A. Rogers has been appointed road foreman of engines of the Baltimore & Ohio Southwestern R. R., with office at Seymour, Ind.

P. G. Leonard has been appointed road foreman of engines on the Hocking Valley Ry. at Columbus, Ohio, succeeding L. C. Engler, deceased.

Henry S. Bryan, superintendent of motive power of the Duluth & Iron Range R. R., at Two Harbors, Minn., died October 2 at Rochester, Wis.

C. A. Kothe, assistant general foreman in the Jersey City, south side, shops of the Erie Railroad, has been promoted to general foreman at Bergen, N. J.

A. M. Gracie has been appointed foreman of the car department of the Northern Central Ry. at the Elmira, N. Y., shops, succeeding J. W. Hawthorne, deceased.

C. H. Norton, general foreman at Bergen, N. J., on the Erie Railroad, has been transferred to Jersey City in a similar capacity, succeeding F. H. Murray, promoted.

W. A. Yanda has been appointed machine foreman on the Northern district of the Rock Island Lines, with office at Cedar Rapids, Iowa, succeeding P. F. Low, resigned.

H. F. Wardell has been appointed superintendent of motive power and equipment of the Chicago & Western Indiana R. R., and of the Belt Railway Company of Chicago.

Chas. Drury, general foreman at Albuquerque, New Mexico, has been appointed division master mechanic at Arkansas City, on the Atchison, Topeka & Santa Fe Ry.

G. W. Russell, master mechanic of the New York, Philadelphia & Norfolk R. R. at Cape Charles City, Va., has been appointed general equipment inspector of that road.

C. A. Brandt has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., and the Peoria & Eastern Ry., with headquarters at Indianapolis, Ind.

C. James, formerly master mechanic on the Erie Railroad at Port Jervis, N. Y., has been transferred in a similar capacity to Jersey City, N. J., succeeding John J. Dewey, resigned.

C. M Stone has been appointed machine foreman on the Terminal and Illinois divisions of the Rock Island Lines, with office at Chicago, succeeding W. Marks, assigned to other duties.

F. A. Chase, formerly general mechanical inspector of the Chicago, Burlington & Quincy R. R., has retired from active service after almost 61 years of railway and mechanical work.

M. A. Kinney, master mechanic of the Hocking Valley Ry. at Columbus, Ohio, has been appointed superintendent of motive power, with office at Columbus, succeeding G. J. De Vilbiss, deceased.

F. H. Murray has been promoted from general foreman of the Erie Railroad shop in Jersey City, N. J., to master mechanic of the Delaware division of that road, with office at Port Jervis, N. Y.

W. J. Hill, formerly division master mechanic of the Atchison, Topeka & Santa Fe Ry., at Arkansas City, Kan., has been appointed division master mechanic at Amarillo, Tex., vice J. R. Cook, resigned.

O. S. Jackson, master mechanic of the Chicago, Indianapolis & Louisville Ry., at Lafayette, Ind., has been appointed superintendent of motive power, with office at Lafayette, succeeding John Gill, resigned.

Garrett Vliet, assistant master mechanic of the Grand Trunk Ry., at Portland, Me., has been appointed master mechanic of the Western division, with office at Battle Creek, Mich., succeeding W. Hamilton, resigned.

Paul L. Grove, assistant master mechanic at the Altoona shops of the Pennsylvania Railroad, has been appointed assistant engineer of motive power of the Buffalo division of that road, with office at Buffalo, N. Y.

James L. Cunningham has been promoted to master mechanic of the New York, Philadelphia & Norfolk R. R. at Cape Charles, Va. He was formerly assistant master mechanic on the Pennsylvania R. R. at Williamsport, Pa.

L. L. Wood, formerly general foreman of shops of the Evansville & Terre Haute R. R., and since August acting superintendent of motive power, has been appointed superintendent of motive power, with office at Evansville, Ind., succeeding G. H. Bussing, resigned.

C. L. McIlvaine, assistant engineer of motive power of the Buffalo division of the Pennsylvania Railroad, at Buffalo, N. Y., has been appointed assistant engineer of the Erie division of the Pennsylvania Railroad and the Northern Central Ry., with office at Williamsport, Pa., succeeding J. L. Cunningham, promoted.

P. H. Cosgrove has been appointed General Car Inspector, to look after all matters pertaining to Car Equipment, Repairs and Inspection, with jurisdiction over the Oregon Short Line R. R. and Southern Pacific Ry. lines east of Sparks. Previous to accepting this position Mr. Cosgrove was General Car Foreman of the Denver & Rio Grande R. R.

Archibald C. Robson, for many years stationed in Buffalo as master car builder of the Lake Shore & Michigan Southern Ry., died October 6, at his home in that city, aged 80 years. Since retirement from the railroad service he had been the founder, and for many years was president and vice-president, of the Erie Savings and Loan Association. He was also one of the founders of the Central Railway Club.

J. T. Brady, superintendent of shops of the New York, New Haven and Hartford R. R., at New Haven, Conn., has been transferred to the Readville shops, and Geo. Donahue, superintendent of shops at Readville, has been transferred to New Haven. Mr. Brady was for several years master mechanic at Norwood Central, Mass., in charge of the Midland division of the New Haven road, and he now returns to within a few miles of the scene of his earlier efforts.

FOR YOUR CARD INDEX

Some of the more important articles in this issue arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.

Acetylene Welding Torch AMER. ENG., 1910, p. 431 (November).

An article by J. F. Springer in which the mixing of the gases in the tip is considered, with a general discussion on the method of obtaining the high temperature, and how to use the torch in practical work.

Apprenticeship System—Erie Railroad AMER. ENG., 1910, p. 445 (November).

Brief notice, showing the success that has accompanied the apprenticeship system on this road after its first year.

Boiler—Locomotives AMER. ENG., 1910, p. 421 (November).

A review of the reports presented at the recent session of the International Railway Congress. These reports indicate a sad lack of uniformity in practices in the various countries and offer little prospect of immediate improvement. This article is confined very largely to a discussion of foreign practices.

Car—Stock—P. R. R. AMER. ENG., 1910, p. 446 (November).

Illustrated description of some excellent stock cars recently put into service on the Pennsylvania R. R.

Locomotive, 2-8-8-2 Type AMER. ENG., 1910, p. 427 (November).

Total weight, 448,750 lbs.
Weight on drivers, 405,400 lbs.
Wheels, 56 in. diameter.
Cylinders, 20 and 40 x 32 in.
Tractive effort, 97,200 lbs.
Total heating surface, 5,203 sq. ft.
Feed water heating surface, 694 sq. ft.
Steam pressure, 210 lbs.

Built for the Virginian Ry. by the Baldwin Locomotive Works, for service on a 2 per cent. grade.

Locomtoive 2-8-0 Type AMER. ENG., 1910, p. 449 (November).

Total weight, 215,700 lbs.
Weight on drivers, 189,200 lbs.
Cylinders, 23 and 30 in.
Tractive effort, 42,800 lbs.
Wheels, 63 in.
Total heating surface, 3,369.2 sq. ft.
Steam pressure, 200 lbs.

Designed and built by the C. M. & St. P. Ry.

Locomotive, 4-6-2 Type AMER. ENG., 1910, p. 448 (November).

Total weight, 248,800 lbs.
Weight on drivers, 160,100 lbs.
Cylinders, 23 x 28 in.
Tractive effort, 26,500 lbs.
Wheels, 69 in.
Total heating surface, 3,910 sq. ft.
Steam pressure, 200 lbs.

Designed and built by the C. M. & St. P. Ry.

Locomotive—4-6-4 Type AMER. ENG., 1910, p. 435 (November).

Total weight, 236,000 lbs.
Weight on drivers, 135,000 lbs.
Cylinders, 20 and 26 in.
Superheating surface, 366 sq. ft.
Wheels, 63 in.
Total heating surface, 1,801 sq. ft.
Steam pressure, 200 lbs.
Tractive effort, 28,100 lbs.

A powerful suburban tank locomotive, designed and built by the Canadian Pacific Railway. The design includes a number of parts built up of steel plates and shapes. These are fully illustrated in this article.

Machine Tools—16-Inch Crank Shaper AMER. ENG., 1910, p. 454 (November).

A new 16-inch shaper designed by the Stockbridge Machine Tool Co.

Machine Tools—Electric Drive for Planer AMER. ENG., 1910, p. 455 (November).

A new electric speed controller applied to the Cincinnati planer. Permits a wide variation of the traverse and return of the table.

Machine Tools—Hollow Chisel Mortiser AMER. ENG., 1910, p. 453 (November).

Powerful machine built by the Bentel and Margedant Co. Specially adapted for railroad car shops.

Piece Work—The Pioneer in Introducing AMER. ENG., 1910, p. 428 (November).

A review of the Baltimore & Ohio experiment of 20 years ago in introducing piece work in the motive power department.

Shops—S. P. R. R. at Empalme, Mex. AMER. ENG., 1910, p. 444 (November).

Brief, illustrated description, largely considering electric equipment.

Valve Gear AMER. ENG., 1910, p. 442 (November).

Fully illustrated description of the improved Baker-Pilliod valve gear.

Wheels—Test for Determining the Roundness of Chilled AMER. ENG., 1910, p. 425 (November).

Report of some careful measurements made on newly cast wheels, with illustrations showing in an exaggerated form the shapes discovered; also suggestions for improving the practice to obtain better results.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Water Softener.—The L. M. Booth Company, 136 Liberty St., New York, has issued a circular describing the type "G" Booth water softener, which appliance has met with hearty approval for its simplicity of construction.

Lock Nuts.—The Columbia Nut and Bolt Co., Inc., Bridgeport, Conn., has issued two illustrated booklets describing the "Original" and the "Improved" lock nut, and pointing out its superiority over other forms of tight fastenings for bolts.

Single Phase Induction Motors.—Bulletins 3139 and 3140, issued by the Emerson Electric Mfg. Co., St. Louis, Mo., describe respectively the back-geared types with countershaft, of 1/3 and 1/2 horse power, and the full load clutch types of 1/20 to 1/2 horsepower.

Car Ventilators.—A circular issued by Burton W. Mudge and Company, 1023 People's Gas Building, Chicago, Ill., describes the Garland car ventilator for interurban, street, elevated, subway and tunnel cars, and thoroughly explains the simple working of the system.

Adaptability of the Gisholt Lathe.—This is the title of a leaflet issued by the Gisholt Machine Co., Madison, Wis., on which is illustrated the range of work that may be finished on these lathes. The description and cuts incidental to the finishing of a twin cylinder for an automobile engine are of much interest.

Locomotive Superheaters.—The advantages of superheating are well presented in a pamphlet issued by the Locomotive Superheater Co., 30 Church St., New York, in which the company's types A, B and C superheaters are fully described and illustrated, and much valuable information is presented in concise form relative to the general question of superheating.

Flexible Transmission.—Bulletin No. 22, issued by the Coates Clipper Mfg. Co., Worcester, Mass., presents largely through illustrations, which are self-explanatory, the variety of uses to which flexible power transmission can be applied. The book contains 66 pages and over 100 fine cuts of the tools manufactured by the company and their method of application.

Leather Belting.—"The Difference Between Albeco Laminated and Multi-Lap Leather Belting" is the title of a booklet being distributed by the American Laminated Belting Co., 113 Hudson St., New York. This booklet is especially interesting in that it gives close comparisons of the operating principles, power transmitting qualities and ultimate economy of both types of belting.

Horizontal Center Crank Engines.—Bulletin 182 of the Sturtevant Engineering Series, issued by B. F. Sturtevant & Co., Hyde Park, Mass., describes the H. C. 1 horizontal center crank engines, and contains interesting and valuable tables covering net horsepowers, etc. The bulletin also includes a lettered diagram and table of principal dimensions for engines of all sizes in class H. C. 1.

Heating and Lighting.—The Safety Car Heating and Lighting Co., 2 Rector St., New York, commenced the issue, October 1, of a new publication called "The Safety Heating and Lighting News," the object of which is to place before railroad men matters of interest relating to lighting and heating railroad cars and allied subjects. The contents of the initial number have been carefully selected and it contains much interesting matter on these important subjects.

Electric Light and Power Machinery.—A very attractive souvenir bulletin of the inspection trip of Cincinnati's commercial organizations to the new plant of the Triumph Electric and the Triumph Ice Machine Companies, Cincinnati, O., on April 30, 1910, is now being distributed. In addition to an account of the inspection proceedings, the book contains a history of the company and is beautifully illustrated with photographic reproductions of interesting views about the plant.

Standard Specifications.—The Carnegie Steel Co., Pittsburg, Pa., has issued a very valuable pamphlet under the above title, which covers comprehensively and in compact form the standard specifications for structural steel, special plate and rivet steel, building, bridge and ship material, concrete reinforcement bars, forgings, axles and wheels, and structural nickel steel, as adapted by the Association of American Steel Manufacturers, the Carnegie Steel Co. and the American Society for Testing Materials.

Train Lighting.—Bulletin No. 4769, issued by the General Electric Company, Schenectady, N. Y., entitled "Train Lighting with G-E Mazda and Tantalum Lamps," should be of interest to all connected with this branch of transportation. Owing to the high efficiency of these lamps they are admirably adapted to this service, while the strong filament of the Tantalum and the flexible mount of the Mazda filament renders them capable of withstanding the sudden jars and shocks incident to railway service.

Bolt Threading and Tapping Machines.—This subject is thoroughly covered from a productive standpoint by the Webster and Perks Tool Co., Springfield, O., in a 30 page catalogue, which fully describes and illustrates the line of bolt pointing, threading and special tapping machines manufactured by that company. The catalogue calls particular attention to the many very material improvements and additions to the line of horizontal threading and special tapping machines which have followed since the inception of the company's business in 1891, and a very cleverly arranged half-tone plate is included, illustrating the wide range of work of which these machines are capable. The catalogue also contains tables of speeds for cutting bolts and tapping nuts, and other information of value to those interested in this machinery.

NOTES

The T. H. Symington Co.—On November 1st the Chicago offices of this company will be moved from Railway Exchange to Suite 623-625 People's Gas Building.

Wells Brothers Co.—In mentioning last month the removal of this company from 125 Chambers St., New York, to 90 Worth St., the latter address should have been 90 Centre St., where a full and complete stock of screw cutting machines will be carried.

Westinghouse Electric & Manufacturing Co.—This company has received from the Boston and Maine R. R. a contract for the entire equipment in connection with the electrification of the Hoosac Tunnel, under the Hoosac Mountain, in Massachusetts.

Triumph Electric Co.—The above company of Cincinnati, O., announces the following change in address and management of its Chicago offices: W. R. Bonham succeeds F. L. Merrill, as manager, and is located at No. 275 La Salle St., instead of in the Manhattan Building as formerly.

McKeen Motor Car Co.—The Southern Pacific Ry. has placed an order with this company for one 70-ft. motor car, and it will build a similar one for the Rock Island lines. It has also recently delivered a 70-ft. gasoline motor car to the Chicago Great Western Ry. for service out of St. Joseph, Mo.

Burton W. Mudge & Co.—This company, of Chicago, Ill., has elected Robert D. Sinclair, secretary and treasurer. Mr. Sinclair, in accepting this position, retired from one of the most responsible positions in the First National Bank of that city, with which institution he had been connected for many years.

Atlantic Works, Incorporated.—It is announced from the Philadelphia office of this firm that Thomas T. Power, James J. Power, and Lawrence C. Power, of the firm of L. Power & Co., Philadelphia, Pa., have purchased control of all the stock of the above corporation, and in the future will assume complete charge of all its affairs.

Baldwin Locomotive Works.—C. H. Peterson, hitherto connected with the Chicago office of the Baldwin Locomotive Works and the Standard Steel Works Co., has been appointed Southwestern representative of these companies with office at 914 Security Building, St. Louis, Mo. Edward B. Halsey, who has been in charge of the St. Louis office, has been transferred to the sales department of the Philadelphia office.

Galena Signal Oil Co.—Recent government tests of this company's improved oil for locomotive headlights, known as Galena Railway Safety Oil "B," show it to produce, with headlights of ordinary construction, a minimum of 1,800 candle power. In the instance of a headlight equipped with sixteen-inch optical lens, costing no more than the initial cost of the ordinary reflector, and much less for maintenance, the minimum candle power increased to 2,400.

Gisholt Machine Co.—It is mutually announced by this company of Madison, Wis., and the Joseph T. Ryerson and Son, Chicago, that an association of interests has been formed in the manufacture and sale of machinery and machine tools. Extensive additions will be made at once to the Gisholt plant which will greatly increase the output of that company, and permit of development which the association of one of the leading machine tool builders with a strong machinery organization would seem to prophesy.

J. G. White & Co.—This firm of engineers and contractors, New York City, has been awarded a contract by the New York, Ontario & Western Railway Company for the erection of railroad shops at its Mayfield yards, Mayfield, Pa., near Carbondale. The work to be carried out consists of a ten stall roundhouse, with a 75-foot turntable, machine shop, carpenter shop, with complete power plant; storehouse, office building, oil building, sand storage, drier and loading house; and a complete coaling station, with a storage capacity of approximately 1,000 tons. The buildings will be of the usual type of brick and steel construction. The estimated cost is approximately $150,000.

An Excellent Locomotive Terminal

THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD COMPLETED ABOUT SIX MONTHS AGO AT CORNING, NEW YORK, A LOCOMOTIVE TERMINAL CONSTRUCTED FROM THE PLANS ADOPTED AS STANDARD AFTER SEVERAL YEARS' INVESTIGATION AND STUDY OF THE SUBJECT. OTHER TERMINALS THROUGHOUT THE SYSTEM HAVE BEEN AND ARE BEING CONSTRUCTED FROM THE SAME STANDARD PLANS.

In many ways the facilities provided for properly taking care of locomotives in service are the most important under the motive power department's jurisdiction and in fact at times are the most important features of the whole scheme of operation. That this fact is thoroughly appreciated by the officials of the New York Central Lines is clearly evidenced by the character of the terminals, which are now being erected. The beginning of the movement for uniform high class locomotive terminals on this road dates back a number of years to the appointment of carefully selected committees who gave the whole subject the most careful investigation and study, and whose reports were most thoroughly discussed by all of the departments interested; sufficient time and attention being given to the subject to permit thoroughly satisfactory compromises on points where there was a difference of opinion between the different departments.

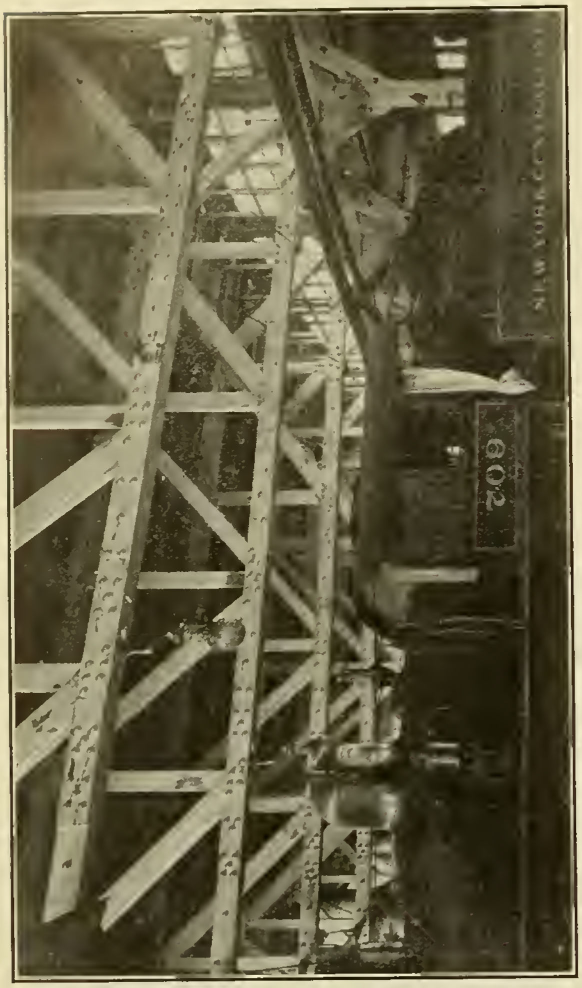
Following this preliminary work standard designs were drawn up in so far as it was possible to do so. These standards were, of course, arranged to have sufficient flexibility to allow for the varying demands of different points and include such matters as section of the enginehouse, diameter and type of turntable, heating system, lighting, construction of pits and floors, cinder pits, general track arrangement, type of architecture, etc. It has been found advisable to change the original standards in a number of small details after experience, but in general they are the same as were originally adopted and from them five or six terminals of various sizes have been constructed and others are in the process of being built.

At Corning, N. Y., on the old Fall Brook Road, a new location was selected for the yard and the terminal which accompanied it forms probably the best example of the standard construction and is a practically ideal locomotive terminal of its size.

The traffic on this road consists very largely of coal and is such as to require the turning of 80 locomotives in 24 hours on an average. These are principally of large consolidation type. Although the enginehouse has 30 stalls, six of these are in the drop pit section and are used ordinarily for light repair work, leaving but 24 stalls for terminal service. On the basis of 80 engines every 24 hours, this gives an average of seven and a quarter hours for each engine to remain in the house. Since practically all of the crews have regularly assigned engines and the crews have at least eight hours rest, storage tracks are provided for holding the locomotives that are waiting for their crews.

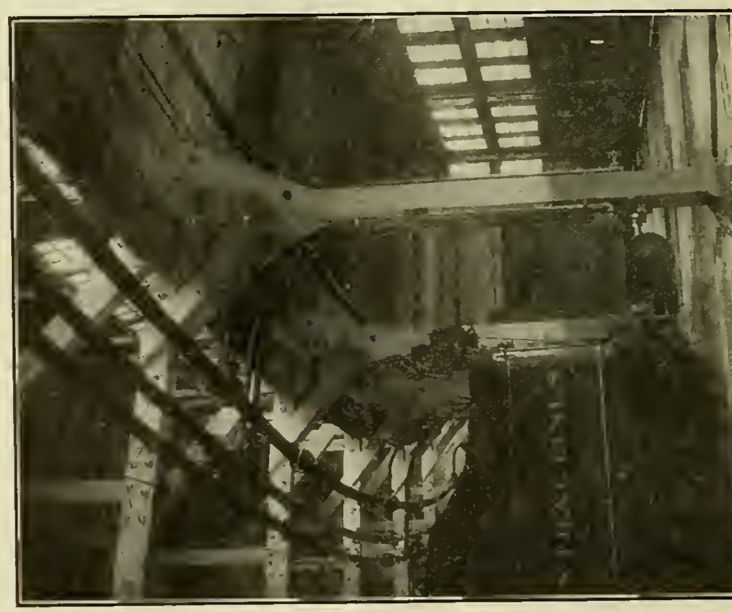
Reference to the general plan of the terminal on page 463 will show that when incoming engines entering from the left are abandoned by their crews near the coaling station, the crews,

GENERAL VIEW OF THE NEW LOCOMOTIVE TERMINAL ON THE NEW YORK CENTRAL LINES AT CORNING, N. Y., TAKEN FROM THE TOP OF THE COALING STATION

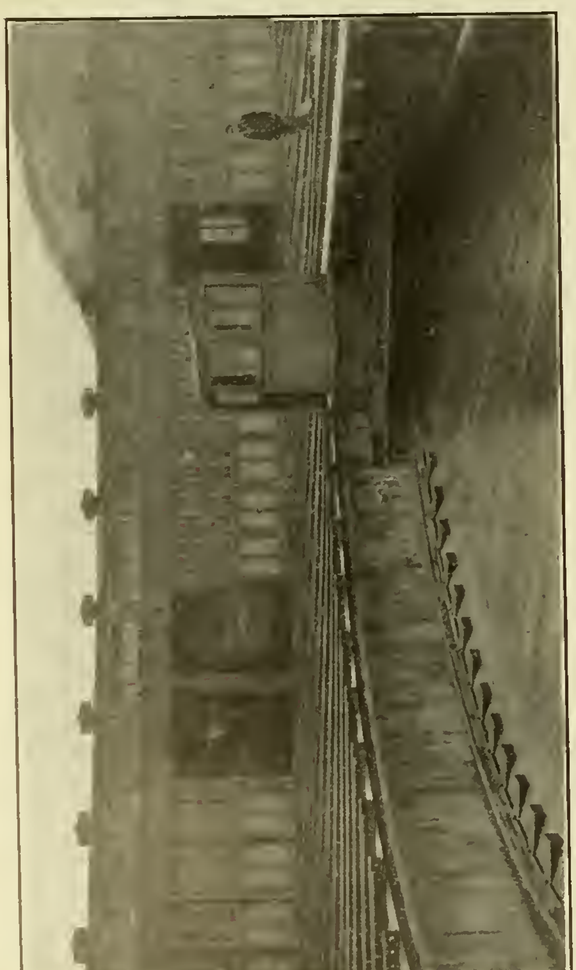


GENERAL INTERIOR VIEW SHOWING ROOF TRUSSES AND ELECTRIC LAMPS

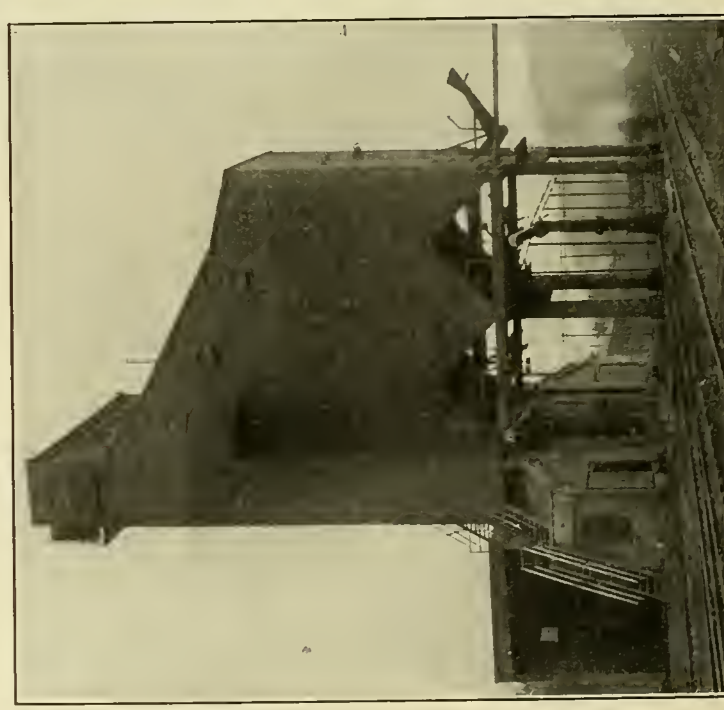
PITT BALANCED ENGINE HOUSE DOORS



HOT WATER WASHING AND FILLING SYSTEM—CONNECTIONS IN THE ENGINEHOUSE



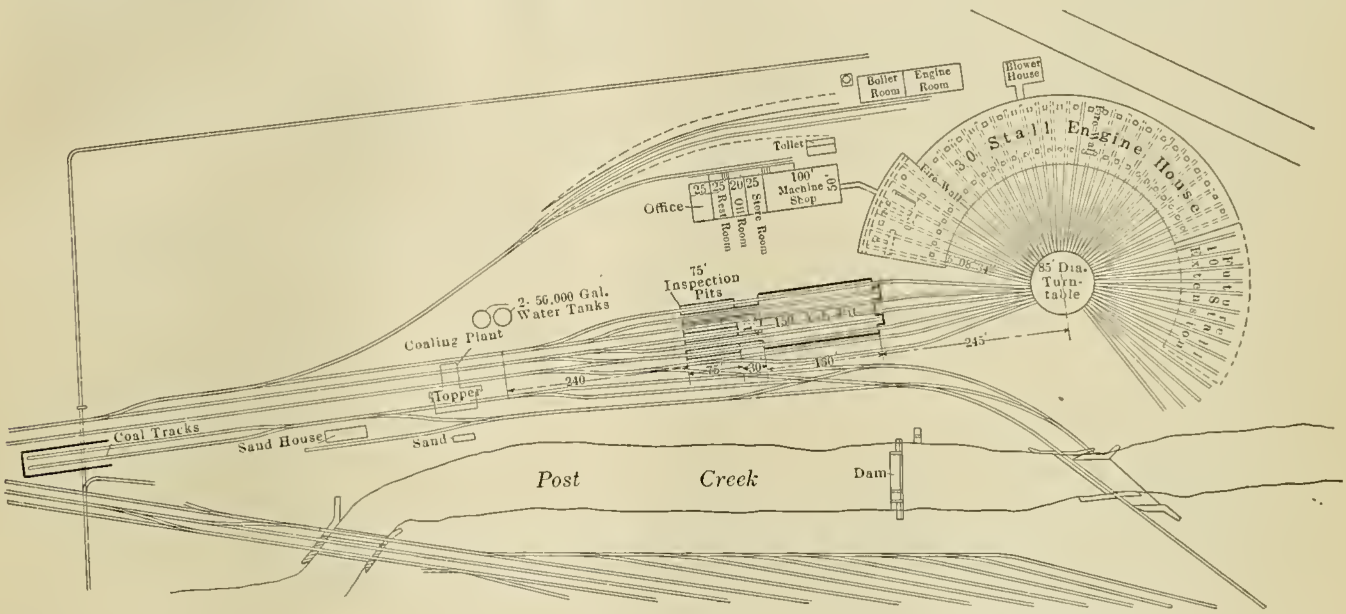
VIEW SHOWING ELECTRICALLY OPERATED TURNTABLE AND EXCELLENT TURNTABLE PIT



REINFORCED CONCRETE COALING STATION

checking their oil cans, tools, etc., in the small building provided for the purpose near the coaling station, walk down to the inspection pits and deliver their work report. A hostler takes the locomotive at this point, coals, sands and waters it and places it upon the inspection pit, whereupon he returns for another engine. After being inspected another hostler takes it to the ash pit adjoining and after the fires are cleaned puts it into the enginehouse. Although four inspection and four ash pits are shown in the drawing but three have been constructed for the present. The arrangement at the coaling station is such that coal and sand are taken at the same time on any of the three tracks and the water cranes are far enough away to allow an engine being coaled while another is taking water.

In addition to the enginehouse and coaling station there are track arrangement for the storage of loaded and empty coal cars. The receiving hopper is 36 ft. long, located at one side of the station proper and is covered with a concrete canopy, the loaded cars from the storage tracks being run down over it largely by gravity. Hopper bottom cars are used altogether for the coal supply and they discharge upon a grating of ¾ x 4 in. bars spaced 15 in. apart in both directions, through which the coal passes to a revolving feeder at the bottom of the hopper. This feeder measures the charge of coal delivered to the elevator buckets and prevents the overfilling of the buckets and the spilling of the coal into the bucket pit. The buckets are automatically loaded and unloaded, and are of 1½ tons capacity each. They are designed to be operated at such a speed as to give an elevating capacity of 75 tons per hour. Actually,



TRACK ARRANGEMENT AND LOCATION OF BUILDINGS AT CORNING LOCOMOTIVE TERMINAL

three other buildings of importance in connection with the terminal; one measuring 50 ft. in width and 195 ft. long, houses a machine shop 50 by 100 ft., a storehouse 25 by 50 ft., an oil room 20 by 50 ft., an engineers' rest room and a general foreman's office. Another building contains the power plant and a third is the blower house, which is connected to the enginehouse by a covered passageway. The bird's-eye view on page 461 shows the general appearance and relative size of these structures.

A study of the track arrangement will show that all possible contingencies of operation have been provided for. Most of the outgoing locomotives pass over the bridge to the right and suitable tracks are provided for this switching movement, so as to prevent all possible interference in case of accident. Arrangements are made to pass the locomotive directly from the coaling station to the house without going on to the cinder pit and also to get one locomotive ahead of another after it leaves the coaling station, if so desired. In studying this track arrangement it should be remembered that practically nothing but freight and switch engines are housed at this point.

Coaling Station.

For its capacity the coaling station at Corning is a model of its kind. The structure is of reinforced concrete throughout and the coal pockets have a storage capacity of 300 tons. It is of the original balanced bucket or Holman type and is operated by electric power. The locomotives take coal on three tracks, two directly below the bins and one at the outside. Reference to the photograph shows the general appearance of the station, which has an extreme height above the rail level of 76 ft. 3 in. The width of the section containing the pockets is 22 ft. The elevator section is 31 ft. 8 in. in width and the receiving hopper and hoist sheds are extensions from this.

Reference to the general plan of the terminal will show the however, the plant has shown itself capable of elevating 50 tons in less than one-half hour.

No provision is made for weighing the coal, except as it is weighed in the car and the amount delivered to each locomotive is estimated altogether by the appearance of the tender. With this exception it is probably the most thoroughly equipped plant in the country. It is electric lighted throughout and is provided with automatic features to prevent any possible accident. The hoisting drum is operated by an electric motor of the induction type and limit switches are provided to prevent overwinding of the cable. Steel stairways and gangways are arranged to give easy access to all parts of the structure.

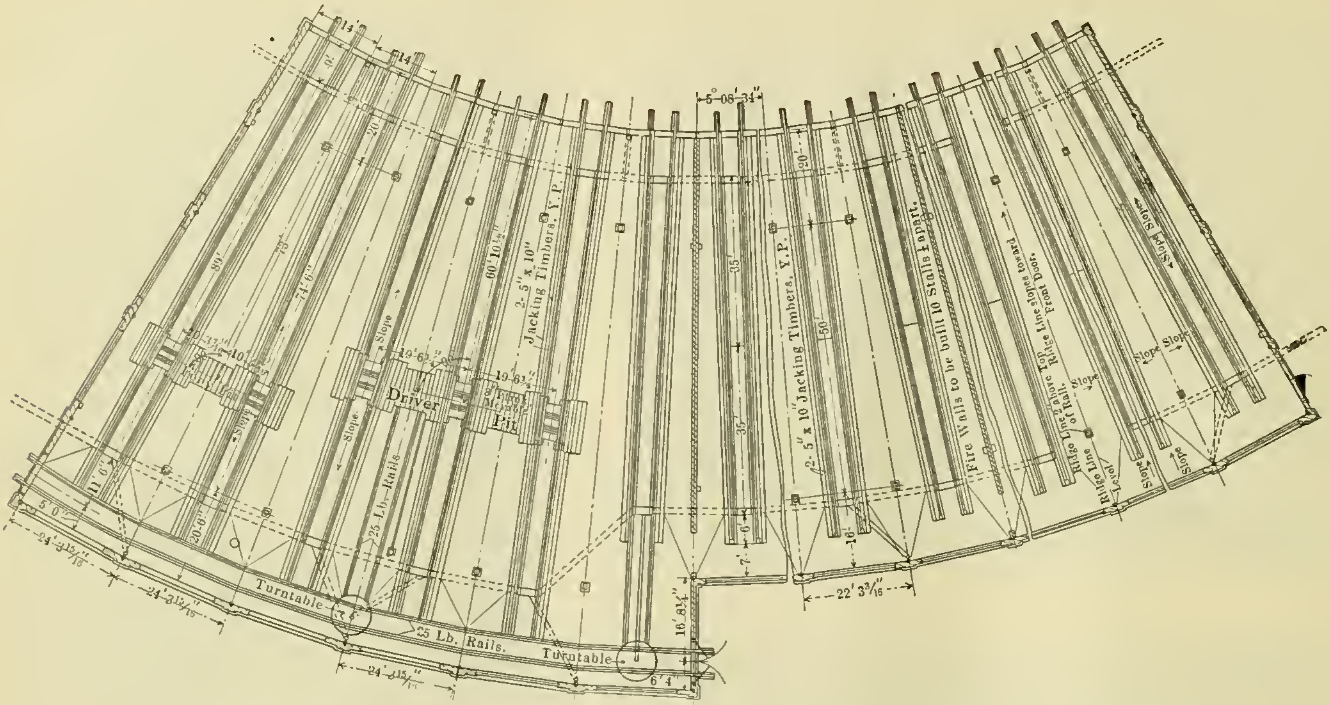
An unusual provision and one of decided value in cold climates is found in the steam coils around all of the gate openings; underneath the feeder in the receiving hopper and in the bucket pit; in the motor house; in the top of the monitor and other places where needed. These coils keep the station throughout at a temperature considerably above freezing and greatly assist in its reliable operation under all conditions.

In addition to the coal storage there are two concrete bins above the coal pockets for the storage of dry sand, with discharges leading to each of the three tracks, so that sand and coal can be taken at the same stop. The sand is dried in a separate structure near the coaling station and is elevated by means of compressed air in the usual manner.

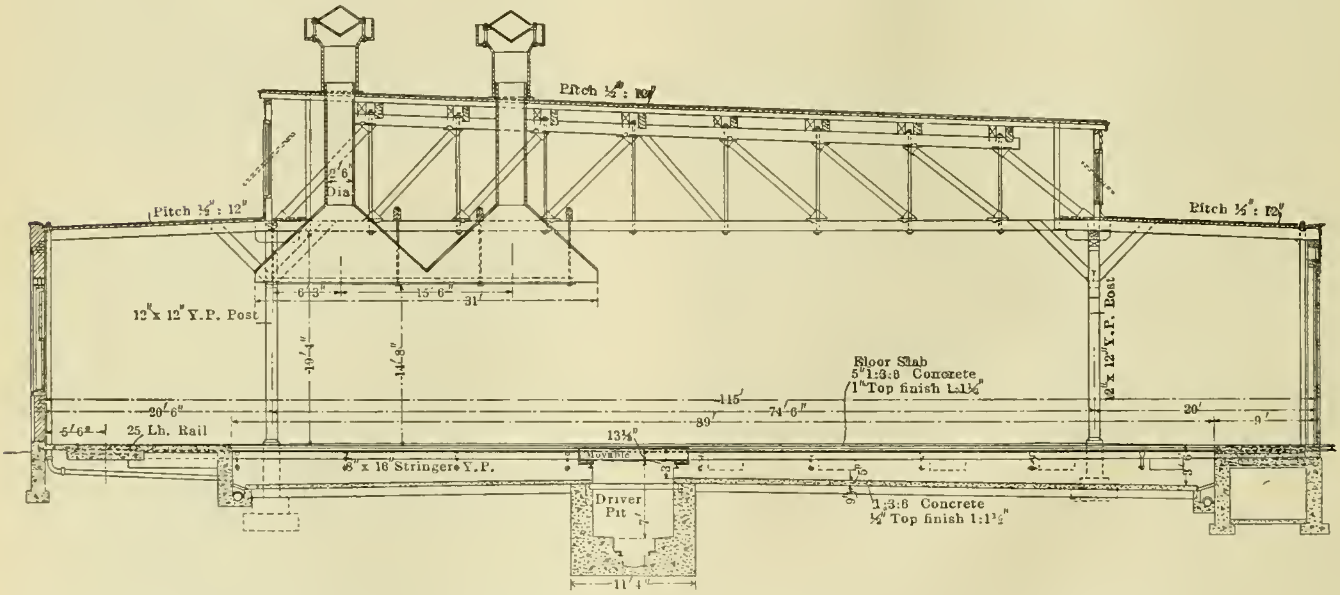
This coaling station throughout was designed and built by the Roberts and Schaefer Co., of Chicago, and is an excellent example of the type of station this company is constructing at various points throughout the country.

Inspection and Ash Pits.

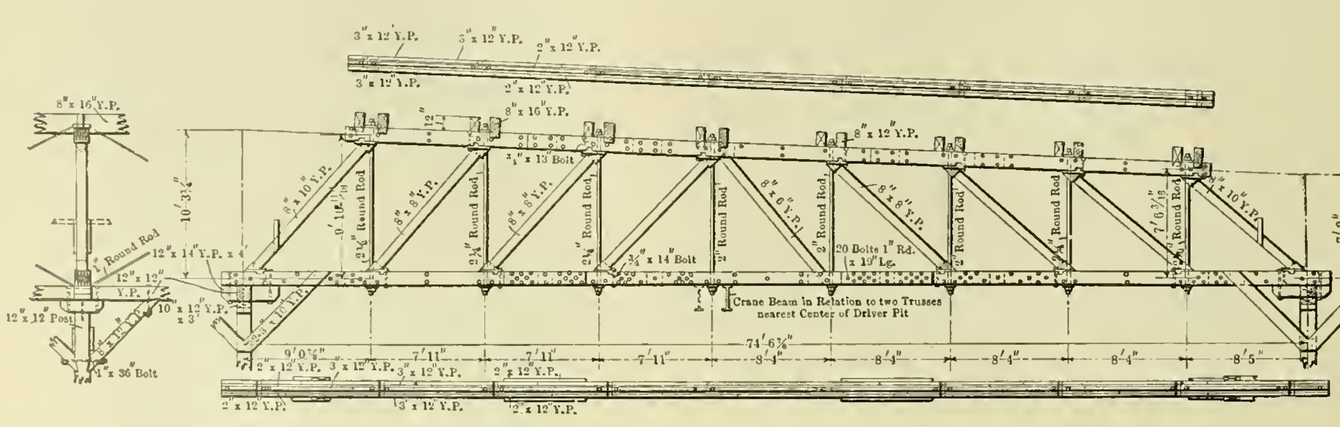
The inspection pits are 75 ft. in length, constructed of concrete with the same general dimensions as the pits in the roundhouse. They are provided with steps at either end. Pending



PLAN OF A SECTION OF THE ENGINEHOUSE—THIS CONSTRUCTION IS STANDARD ON THE NEW YORK CENTRAL



SECTIONAL ELEVATION OF THE STANDARD 115 FT. SECTION FOR ENGINEHOUSES ON THE NEW YORK CENTRAL



DETAILS OF THE ROOF TRUSS IN THE 115 FT SECTION OF THE ENGINEHOUSE the construction of the fourth pit a temporary wooden structure has been provided for the inspectors.

The ash pits are 150 ft. in length and are of the shallow shovel type that has been adopted as standard on this road. Two depressed tracks serve the four pits. These pits are also constructed of concrete, the rails being carried by cast-iron chairs, allowing the pit to extend some distance beyond the outer rail and a wide shoveling platform between the inner rail and the depressed track.

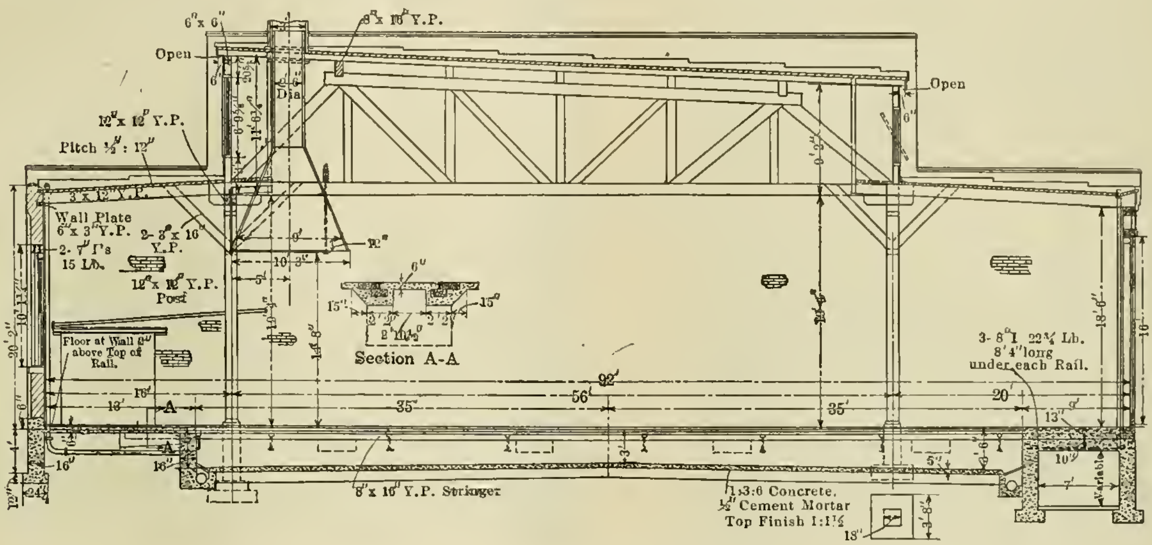
TURNTABLE.

A standard 85 ft. electrically driven turntable is provided, the motor being of the induction type, driving through clutches in the usual manner. The construction of the pit and the general appearance of the track is clearly shown in one of the illustrations. The top of the concrete wall is capped by two inverted rails, which distribute the blow on the end of the track rails. The pit is floored with concrete, insuring good drainage and preventing any heaving of the circular track or the side walls from frost.

ENGINEHOUSE STRUCTURE

The illustrations on this and facing page, together with the various photographs, clearly show the arrangement, size and construction of the enginehouse itself. This construction is from the same standard plans, with a few changes in detail, that were used at the West Springfield house, illustrated on page 5 of the January issue of this journal. All of the foundations are, of course, of concrete and the outside walls are of brick. The major portion of the roof structure is carried by a wooden truss 56 ft. in length, supported by two rows of 12 by 12 in. yellow pine posts. The sections outside of these posts are supported by 3 by 12 in. rafters, the pitch being 1 in 24. It will be noticed in connection with the roof that the gutters drain through leaders placed inside of the wall, which prevents their freezing and the formation of ice on the roof or side walls. These leaders drain into the pits and from there to the sewer. The upper section of the roof inclosing the trusses, has large swinging windows along both sides which are operated from the floor. Six inch openings under the cornice at either end of this section will be noticed, which experience has shown greatly assists the ventilation. In fact, even with the windows in the upper section closed this opening together with the three inch annular space around the smoke jack keeps the house reasonably clear of steam and gases. When the upper windows are also opened the ventilation is practically perfect. This high open roof construction gives excellent natural lighting at the centre of the house. For the purpose of housing the drop pits, and to provide ample room for all necessary movements over the drop pits, the section of six stalls at one end of the house is 115 ft. inside measurement instead of 92 ft. as in the rest of the structure. In this part a somewhat more elaborate roof truss with iron tension members has been provided and is shown in one of the illustrations. This section also provides two smoke jacks over each pit, giving a 31 ft. movement before the stack is out from under a jack. In other respects the longer section is of the same general construction as the rest of the house.

Pits.—The pits in the main portion of the house are 70 ft. in length and 3 ft. in depth at the centre, sloping both ways to a depth of 3 ft. 6 in. The concrete side walls are capped by a 5 x 10 in. timber, bolted to the concrete, to which the running rails are spiked. The concrete foundation is also carried out sufficient to form a support for two 5 by 10 in. timbers placed side by side outside of the rails, which give a perfect foundation for jacks. All of the hot air for heating emerges from eight points, four on either side of each pit, the hot air conduit of concrete being located just at the inner ends of the pit, as is shown in the sectional view. The bottom of the pits is of concrete finished with a ½ in. coat of hard cement mortar.



SECTIONAL ELEVATION OF THE STANDARD 92 FT. SECTION FOR ENGINEHOUSES ON THE NEW YORK CENTRAL

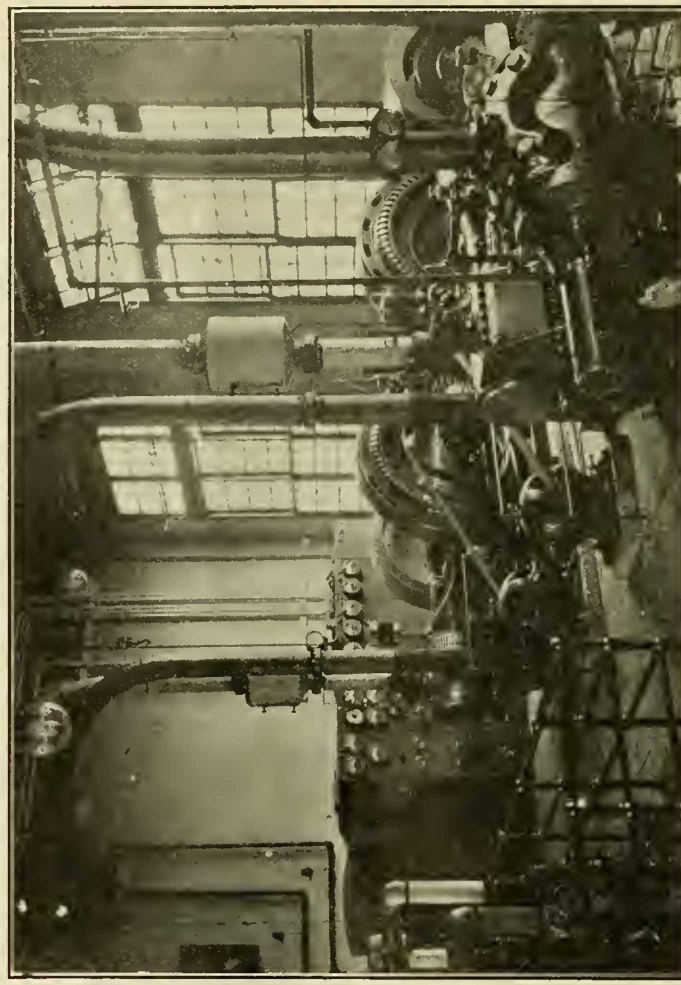
Floors.—Concrete floors 6 in. thick, capped by ½ in. hard cement mortar finish are used throughout the house. Reference to the plan will show the method of drainage, which is arranged to give a good slope and drains from all directions toward the pits. The foundation of the outer wall is carried up several inches above the floor level, so as to prevent seepage of water under the wall at this point.

A full gauge industrial track of 25 lb. rails, with two turntable connections inside the house and a connection to the track leading into the shop will be seen on the plan. This is only provided in the drop pit section.

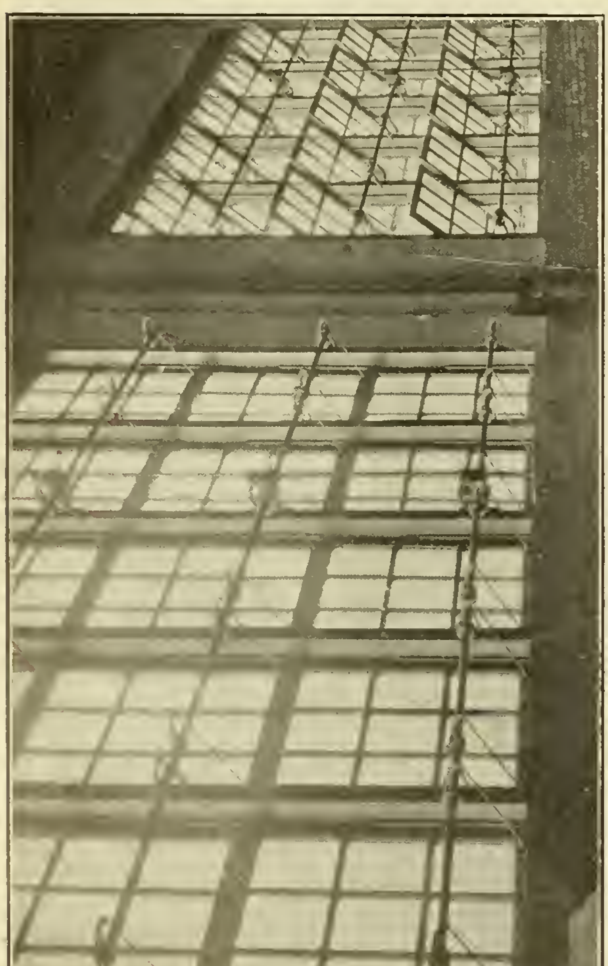
Windows.—One of the illustrations on page 466 gives a view of the windows in the outer wall. It will be seen that each large window is comprised of 15 hinged sash of nine panes each. All of the sash in each set are swung by one operating gear arranged as is shown in the illustration. The windows in the outer wall are 15 ft. 10 in. in length and practically 9 ft. in height. In the louvre the windows in the outer circle have 5 sash, each having eighteen 10 by 12 in. panes of glass and measuring 6 ft. 6 in. in height and 15 ft. 7 in. in width, while those in the inner circle are 4 ft. 4 in. in height and 12 ft. 5 in. in width, there being but four sash in this group, each having twelve 10 by 12 in. panes. In addition to these there are eight standard sash of six lights each in the doors. As can be easily imagined and is clearly shown in the interior views of this house, this gives an excellent natural lighting. The window operating gear throughout the whole plant was furnished by the Dearborn Hardware Co., of Chicago. The artificial lighting will be mentioned later.

Smoke Jacks.—The smoke jacks are moulded from Transite

A SECTION OF THE MACHINE AND FORGE SHOP



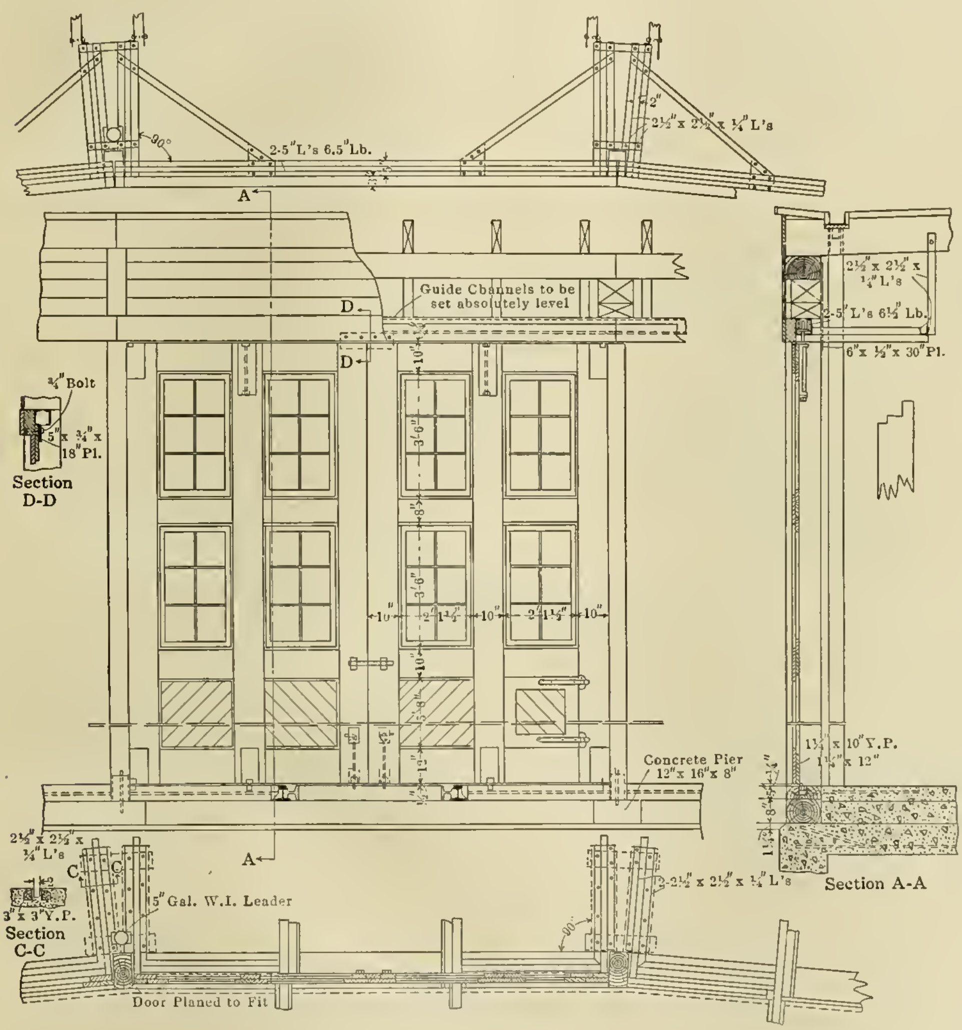
GENERAL VIEW OF ENGINEROOM IN THE POWERHOUSE. AIR COMPRESSOR AT RIGHT AND PUMP PIT AT LEFT



WINDOWS AND OPERATING GEAR IN THE ENGINEHOUSE

PUMPS, PART OF TANKS AND CONNECTIONS FOR THE HOT WATER WASHING AND FILLING SYSTEM asbestos wood, a mineral product proof against the effects of acid, gases, fumes, and climatic conditions and absolutely fire proof. This material is moulded over forms and shipped in sections that are drilled ready for erection. After being installed the bolts, nuts, and washers are coated with Transite cement to protect them against corrosion. This material offers many advantages for this purpose and while it is absolutely fire proof it can be worked much the same as hard wood and has a tensile strength practically equal to hard wood. It is very light and does not require special roof construction to support it. The material does not collect condensation and is not affected by expansion and contraction.

The single jacks have a length of 9 ft. and narrow up to a circular section 2 ft. 6 in. in diameter, which continues to a point slightly above the roof line. Outside of this and resting upon the roof, leaving a 3 in. annular opening between the two



DETAILS OF THE PITT BALANCED DOOR FOR ENGINEHOUSES

sections, is a 3 ft. circular section, arranged as is shown in the cross section of the 115 ft. part of the house. These jacks have wings extending down 12 in. on each side, preventing a clear sweep across the top of the stack, tending to blow the smoke out into the house. In the drop pit section two of these jacks are provided over each pit, being arranged as is clearly shown in the illustration. All of the smoke jacks are supported from the roof truss, which is designed to give ample strength for this purpose. The jacks were designed by the railroad company and manufactured by the H. W. Johns-Manville Co., of New York.

Drop Pits.—Drop pits for driving wheels are provided covering three tracks and for truck wheels covering two separate tracks. There is one track in this section of the house that is not provided with a drop pit of either kind. These pits are provided with the usual telescopic air jack and a noticeable feature is the 12 electric lights in each of the driving wheel pits, these being located in recesses in the side walls, so as to be perfectly protected. The pits are, of course, of concrete throughout and the openings between the tracks are covered with 3 in. planks, which are easily removable. Over the driving pits there is a trolley hoist carried from the roof trusses.

One of the illustrations gives a detailed view of the moveable rail used on these pits, which is considerably more elaborate and satisfactory than is customary. This section of the rail is carried by a girder built up of steel channels and angles, which is provided with small wheels set at the proper angle on to which the weight of the girder can be thrown by means of eccentrics, operated by hand. When the moveable rail is in its normal position the girder is carried on bearing plates at each end, but when it is desired to move it, it is lifted slightly by throwing the weight on to the small wheels, when it can be easily pushed to one side for any desirable distance. The same design of moveable rail is also used in the truck drop pit. As noted above, the drop pits are in a section of the house made 23 ft. longer than that used elsewhere. This practice is standard on the New York Central, where it originated and very materially adds to the usefulness of the house. The greater length available not only gives a greater range of movement for the locomotives on the pits, enabling any wheel on any engine to be removed, but provides the room needful for the shop work, which is the real purpose of providing the drop pits.

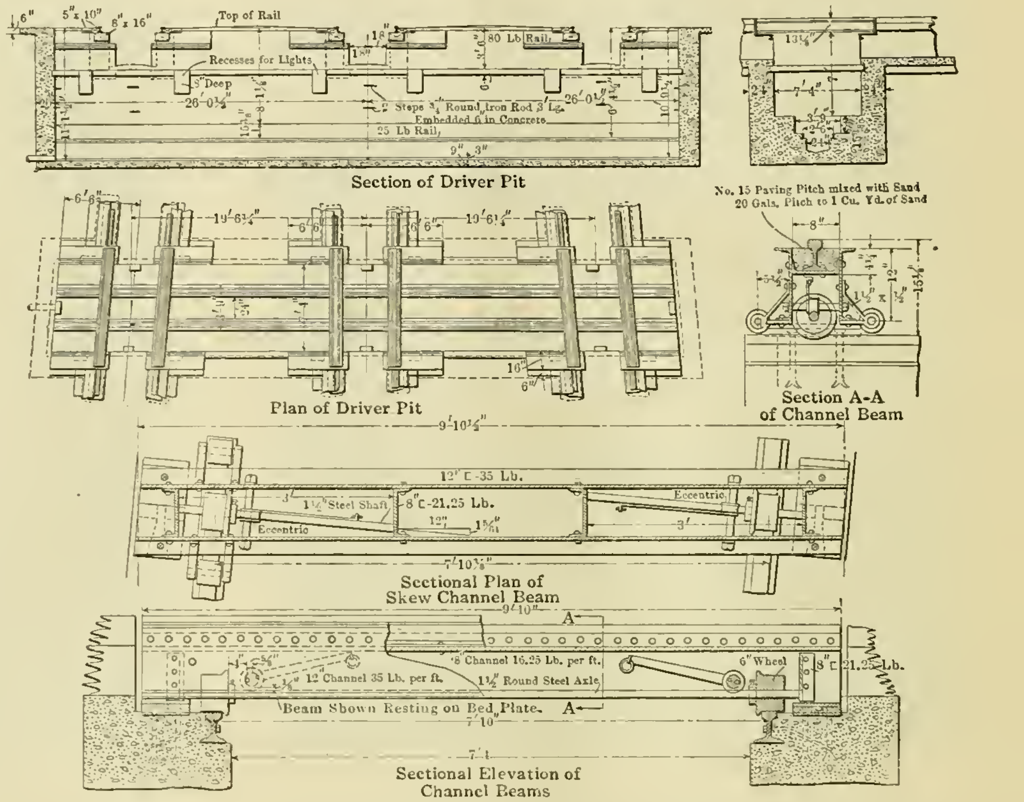
DOORS.

In climates where cold weather, accompanied by high winds and heavy snow fall, is found there is probably nothing throughout the whole locomotive terminal that is more vexatious than the usual heavy swinging enginehouse doors. Many different schemes to avoid this trouble have been applied and at Corning an entirely new design of door is found. This consists of an adoption of the design that has been applied to car gates, doors of telephone booths and in public buildings by the Pitt Balanced Door Co., of New York. The arrangement is such that a combination swinging and sliding motion is provided so that the doors when fully opened extend half of the width inside of the door opening. Inasmuch as with this type of construction the whole weight of the door is carried from a single set of rollers in the centre at the top of each door it is possible to use a decidedly lighter construction than when hinges are employed, greatly assisting in the ease of opening and closing.

This arrangement seems to offer many advantages for enginehouse uses. It permits the installation of the large lighting area so desirable in enginehouse doors. It increases the clearance, allowing the tracks to be set closer together at the inner circle; the large rollers running on an iron track give an easy operation and considerably less snow clearing is required. Doors of this type practically cannot be blown closed with resulting damage to windows and frame work. Because of the lighter construction they are much less liable to warp and swell and because of the substantial top support there is no difficulty with binding at the bottom when the frost heaves the track at this point.

Reference to the illustrations will show the design and operation. The overhead track consists of two 5 in. L's and the interior guides set at 90 degs. with this track are composed of 2½ in. L's, the inner end being supported directly from the roof timbers. The carriage supporting the door at the centre has four running wheels and a horizontal guiding wheel, which insures its easy operation. At the bottom are two guiding pins sliding in slots in the floor, one of these in the centre directly below the roller carriage and the other at the inner corner directly below a similar guide at the top. In operation when the door is pushed outward in the usual manner the side next to the post swings inward guided by the pins and slots as just explained, turning about the support from the roller carriage. As pressure is continued the roller carriage moves toward the post, the inner side continuing to swing inward until full open, when each door is half in and half out of the house lying close against the post and parallel to the track.

While this enginehouse has not yet been through a full winter, the experience of early spring and summer has indicated the entire suitability of the design for this purpose, and while there may be anticipated some trouble with the lower slots filling up or with corrosion of the metal work overhead, it is not believed that this will prove serious. The slots are provided with ample clearance at the ends and any trouble with ice forming can be eliminated by filling the slot with a heavy oil. Constant operation will probably prevent any serious trouble from corrosion of the working parts.



DETAILS OF DROP PITS AND MOVEABLE RAIL

Heating and Lighting.

After a thorough investigation of the subject and the completion of extended trials under the most difficult conditions, the New York Central Lines have adopted the hot air system of heating for enginehouses. The air is conveyed through the house by means of a large concrete duct or tunnel, running around the circle at the inner ends of the pits. At Corning this tunnel is 7 ft. in width and of a varying height, depending upon the area needed. From it is carried out between each of the pits a branch which has four outlets in the sides of each of the adjacent pits, equally spaced throughout its length. Each of the outlets in each of the pits is fitted with dampers. Particular attention has been given to the perfect drainage of this heating conduit and it is provided with no outlets except those in the pits.

In the case of the Corning enginehouse the blower is located in a separate building connected to the enginehouse by a covered passageway. The apparatus is in duplicate, both fans discharging into the large conduit, which is 7 ft. by 7 ft. in section at this point. The heating apparatus was furnished by the Bailey Mfg. Co., of Milwaukee, and each of the two sets consists of a 11 ft. fan 54 in. wide, having a capacity to deliver 88,800 cu. ft. of air per minute at 150 r. p. m. The fans are driven by a 10 by 12 in. horizontal engine direct connected. With each fan there is a heater having 5,000 sq. ft. of heating surface and the whole apparatus has been installed under a guarantee to give 65 degs. temperature in the house with an outside temperature of 10 degs. below zero.

It will be seen that at normal capacity these fans are capable of delivering 177,600 cu. ft. of air per minute, or sufficient to completely change the air in the whole enginehouse every 8 minutes. The effect of this circulation upon the ventilation of the house can be easily understood and in other engine houses in very cold climates it has been found that this system of heating will maintain the guaranteed temperature with ease. With a 30 stall engine house, as at Corning, this apparatus gives 333 sq. ft. of heating surface per pit and a delivery of 5,920 cu. ft. of air per pit per minute.

In the machine shop, offices and other sections of the plant the heating is by direct radiation from steam pipes, the exhaust steam forming the principle supply for all of the buildings with the exception of the coal chute, although high pressure steam can be turned on if necessary. In the machine shop particularly, the large amount of heat radiating surface is very noticeable and because of the very liberal window area it will no doubt be found to be highly desirable in this climate. The radiators consist of from 12 to 15 rows of piping encircling the whole shop underneath the windows, with the exception of the door openings.

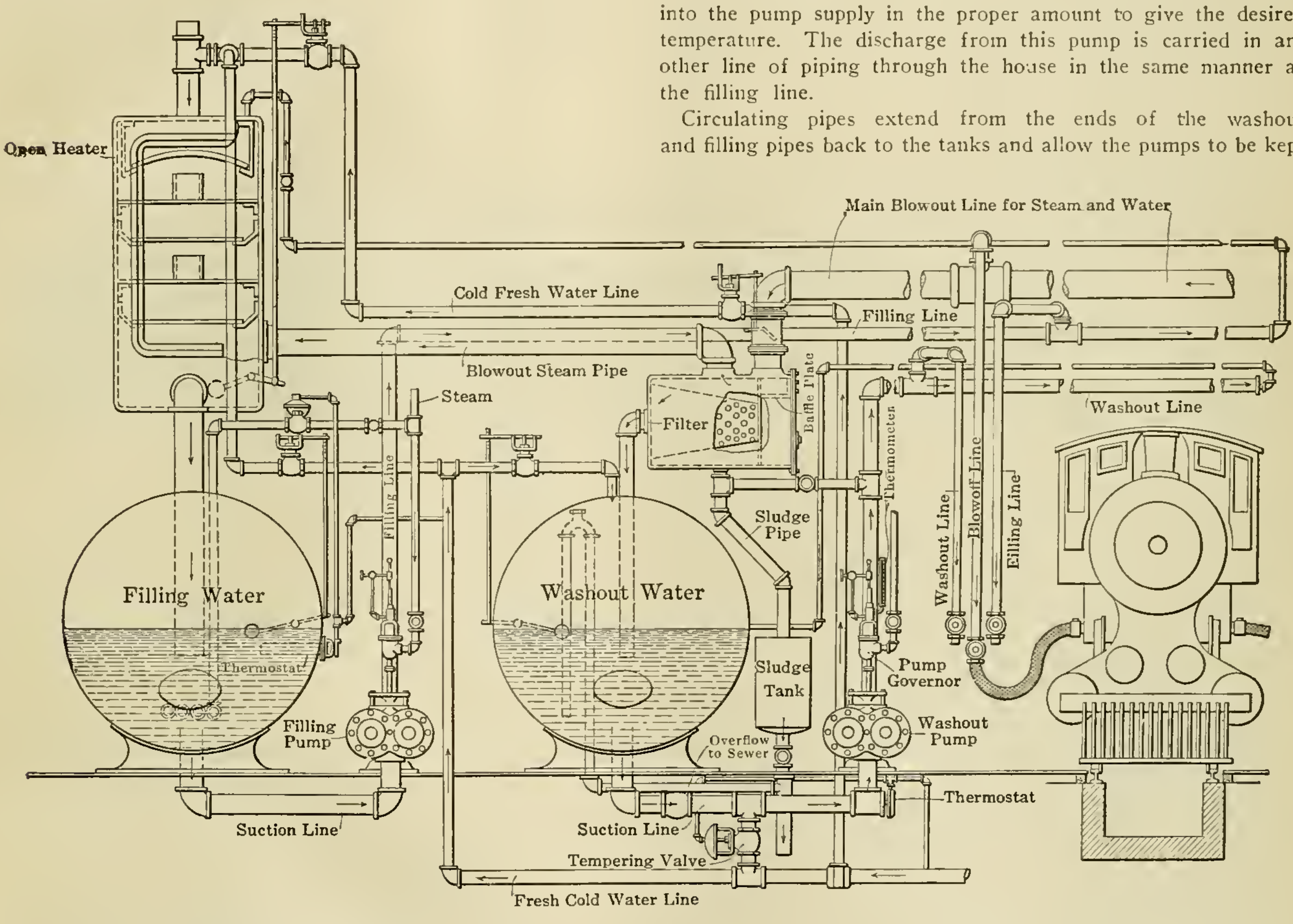
In the enginehouse the artificial lighting is by means of enclosed arc lamps, there being one suspended directly from the roof timbers in the centre of the house, between each of the pits. There are also a few stationary incandescent lamps on the fire walls and at other points. Sockets for portable electrics are located on each post between the pits in the outer row. Incandescent lanps set is recesses, as shown in the illustration, thoroughly illuminating the drop pits.

In the machine shop the lighting is by Cooper-Hewitt mercury vapor lamps, there being six of these evenly distributed and supported from the roof trusses. Lighting in other parts of the plant is by incandescent lamps for interior and arc lamps for exterior lighting. The illumination for the interior of the coaling station is particularly noticeable. All of the lighting is on 110 volt alternating current circuit.

Hot Water Wash-out System.

Recognizing the very great value of a hot water washing-out and filling system, not only as a time saver in turning locomotives but also as a means of reducing flue leakage and engine failure on the road, the New York Central Lines have installed systems of this kind in practically all of the enginehouses built in the past four or five years. Most of the equipments installed are of the same design as that at Corning, which was manufactured and installed by the National Boiler Washing Co. of Chicago. One of the illustration shows, in diagrammatic form, the apparatus and piping connections as used by this system, in which the utmost care has been taken to make it thoroughly automatic in its operation and positive in its results. An investigation at the terminal under discussion showed that the engineer in the power house found it necessary to simply lubricate the pumps and occasionally blow out the sludge tank, and beyond this, no attention was needed, the pressures, temperatures, etc., being automatically maintained within narrow limits.

Referring to the diagram, it will be seen that a locomotive coming in to be washed out is first connected by a hose to the blow-off line, the plug for which is located on every alternate post of the inner circle. From this connection it discharges into the main blow-off pipe, which is carried from the roof timbers around the circle, as is shown in one of the photographs, continuing to the power house, where it discharges into a large closed filter. In passing into the filter it operates a flap valve, which in turn automatically opens a valve in the cold water line to the top of the open heater. The steam and water passing into the filter, hit a baffle plate, and the steam is deflected into the blow-off steam pipe to the open heater located above the filling water reservoir. Here the steam is condensed by the cold water and flows to the storage tank below. A thermostat in this storage tank controls a valve on the live steam line, and live steam is admitted to it whenever the temperature is below that desired, usually 170 to 180 degrees. As a matter of fact, this valve is seldom operated, as the steam from the blow-off water is usually sufficient to maintain the proper temperature. In this tank there is also a float connecting to a valve on the cold water line insuring a sufficient supply of water at the proper temperature for filling at all times. A large, powerful pump draws its supply from this tank and discharges it into the filling line that parallels the blow-off line in the circle around the house and has a drop pipe with a gate valve on the same posts between every two pits.



DIAGRAMMATIC ARRANGEMENT OF THE NATIONAL BOILER WASHING COMPANY'S SYSTEM FOR HOT WATER BOILER WASHING AND FILLING

The blow-off water, after reaching the filter, passes through a cone inclosing filtering material, after which it is discharged into the washout water tank just below. The sludge and scale held back by the filter are discharged into the sludge tank, from which it can be washed into the sewer. The temperature of the water in the washout tank as it comes from the filter will be on an average of about 185 degrees, but as this is too hot to handle in a washout hose, an automatic device is provided for maintaining it at a lower temperature, usually about 130. A valve is placed in a connection between the fresh water line and the suction line for the washout pump and is controlled by a thermostat in this suction pipe, so that cold water is drawn into the pump supply in the proper amount to give the desired temperature. The discharge from this pump is carried in another line of piping through the house in the same manner as the filling line.

Circulating pipes extend from the ends of the washout and filling pipes back to the tanks and allow the pumps to be kept in slow motion all the time, not only maintaining the temperature in the long piping but also insuring the pumps being ready to act more promptly when needed. The filling pump has a capacity of 500 gal. per minute and the washout pump has a sufficient capacity to wash out three boilers at one time, maintaining a pressure of 90 lbs. The filling water tank has a storage capacity of about 12,000 gallons and the washout tank of about 8,500 gallons.

Power House.

A most completely equipped and conveniently arranged power house forms not the least important feature of the terminal. It is enclosed in a separate building of brick, conforming in architecture to the other structures, having steel roof trusses with a flat roof. The natural lighting is excellent, as is clearly shown in the interior view. The structure is divided into two parts, forming a boiler room and engine room, alongside the former being located the trestle from which coal is discharged directly to the floor in front of the boilers. Three 300 h. p. Heine boilers furnish steam for heating and power. They are hand fired and a brick stack 125 ft high provides the draft. In the engine room are located two direct connected sets consisting of 150 h. p. simple engines and 150 kva. alternators, delivering 60 cycle current at 480 volts. A completely equipped switchboard, back of which are located the transformers, is provided in connection with this equipment. The current at full voltage is used for operating the various induction motors throughout the terminal, consisting of a 15 h. p. turn table motor, two 30 h. p. motors in the machine shop and two 22 h. p. motors at the coaling station. The current for lighting is transformed to 110 volts.

A two stage Ingersoll-Rand air compressor, with 1,100 cu. ft. free air capacity provides the compressed air for use throughout the terminal and the yards. Two automatic boiler feed pumps occupy one corner of the engine room and in the pump pit are located two vacuum pumps for the heating system and two large pumps for the service water system, a water presure of 70 lbs. being maintained on the line. The hot water boiler washing and filling equipment occupies one end of the engine room and these pumps are cross connected to be used for fire service. A Cochran feed water heater is also provided.

The force required in the power house consists of a chief and assistant, with one fireman and his helper, days, and one fireman and engineer at night; the heating equipment also being cared for by this same force.

SHOP.

The structure, 50 by 100 ft., enclosing the shop is of the same general construction as the enginehouse, with the exception that steel roof trusses are employed. The windows in this section are particularly large and the two lower sash are arranged for sliding. The upper group, however, are operated on the swinging principle by gear the same as in the enginehouse.

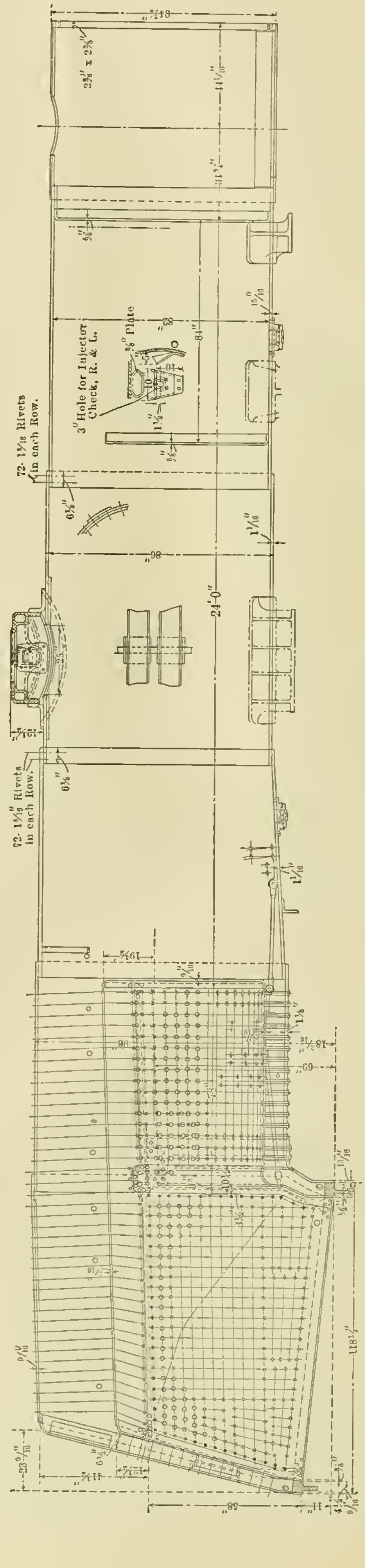
In this shop is located a practically complete outfit for light repairs. It includes two open forges with a steam hammer adjacent, small flanging clamp, flue cutter, hand rolls, together with auxiliary jib crane, anvils, ets., all grouped in one corner, providing excellent facilities for all usual forging or boiler work. Near this section are found a bench for tinsmith, provided with rolls, cutters, etc. In the same locality is also placed a large combination punch and shear.

The machine tool equipment includes, in addition to the above: A large planer, small planer, slotter, radial drill, shaper, driving wheel lathe, boring mill, hydraulic press, upright drill, four engine lathes swinging from 12 to 24 in., pipe threading and cutting off machine, double headed threading and tapping machine, bolt lathe and emery wheel. These machines are all belt driven from line shafting, driven by two 30 h. p. induction motors. The arrangement is such that either one or both of the motors can be used.

A covered passageway connects the shop with the drop pit section of the enginehouse and a track continuing through the centre of the shop provides connection between the two buildings. Air cranes are provided where required and the usual benches, vises and other small equipment is complete. The floor of the shop is of concrete, the same as in the enginehouse and the artificial lighting is by Cooper-Hewitt mercury vapor lamps. Numerous sockets for portable electric lamps are provided.

HOSPITAL

An unusual feature of this terminal is a very completely equipped small hospital, which adjoins the engineer's rest room. Owing to the fact that the hospital facilities of the village are about two miles away and the access to the enginehouse is somewhat difficult, arrangements have been made so that an injured person can be properly taken care of without being taken away in an ambulance. The equipment provides in a large light airy room, two hospital cots, an operating table with a complete outfit of surgical instruments, cold and hot water supply and all other facilities required by modern surgery. In case of accident the railroad surgeon is telephoned for and arrives either by a special engine or automobile and the injured man receives treatment within a very few minutes after the accident and that under strictly sanitary and satisfactory conditions. If he is very seriously injured it is not necessary to move him till he is in a condition to be safely taken to the regular hospital.

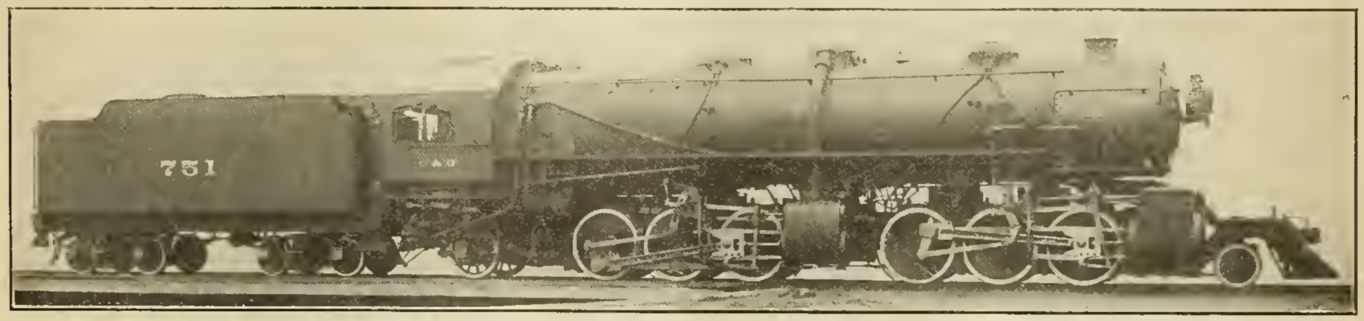


BOILER WITH A SIX AND A HALF FOOT COMBUSTION CHAMBER AND TWENTY-FOUR FOOT TUBES FOR THE CHESAPEAKE AND OHIO 2-6-6-2 TYPE LOCOMOTIVE

Mallet Locomotives for the Chesapeake & Ohio Railway

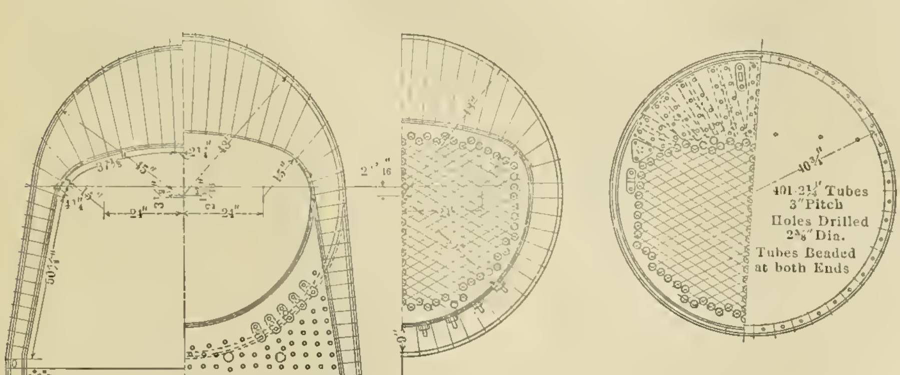
ABOUT SIX MONTHS AGO THE AMERICAN LOCOMOTIVE COMPANY FURNISHED A SAMPLE LOCOMOTIVE TO THE CHESAPEAKE & OHIO RAILWAY OF THE 2-6-6-2 TYPE DESIGNED TO SUIT SPECIAL CONDITIONS ON THAT ROAD. THE SERVICE WITH THIS LOCOMOTIVE HAS RESULTED IN THE PLACING OF AN ORDER FOR TWENTY-FOUR MORE OF THE SAME TYPE.

On the division of the Chesapeake and Ohio Railway between Handley, W. Va., and Allegheny, Va., east bound, there is for a distance of 106 miles a continuous easy up grade varying from 2¼ to 21 ft. per mile, the average for the last 68 miles of this being 19 ft. per mile. On the last 13 miles of the division going into Allegheny the grade is an average of 30 ft. per mile or .57 per cent. The freight traffic on this division has been handled by 2-8-0 type locomotives having cylinders 22 x 28 in., total weight of 190,300 lbs. and a theoretical tractive effort of 41,120 lbs. The rating with this class of engines was 1,800 tons, it being necessary to use a pusher on the 13 mile grade into Allegheny.



MALLET LOCOMOTIVE THAT DRAWS 3033 TONS AT 22 MILES PER HOUR ON A GRADE OF 19 FT. TO THE MILE

The value of heavier train units in reducing the cost of transportation lead the officials of this company to investigate the possibilities of more powerful motive power. In studying the subject it was found that a Mikado type locomotive suitable for the track conditions could be designed that would be capable of handling 2,250 tons over the division if the pusher service was still maintained on the heavy grade. While it was not of prime importance to eliminate the service of the pushers, it was desirable, and a design was then drawn up for a Mallet compound type of locomotive and it was found that an engine of this type suitable for the track conditions could be designed which would handle 3,000 tons over the full length of the division without assistance. In addition it was probable that this type of locomotive would handle the heavier train with even less coal consumption than the Mikado type would handle its tonnage.



SECTIONS OF THE BOILER

Following this investigation the company ordered from the American Locomotive Co. a sample engine designed for this service. This locomotive was delivered last July and was intended to handle 3,000 tons at a speed of 15 miles per hour on a grade of 21 ft. per mile or 12 miles per hour on a grade of 30 ft. per mile, combined with uncompensated curves of 5° 45'. This locomotive soon proved itself to be able to exceed its estimated capacity and has handled 3,492 tons eastward over the full division; and with a load of 3,033 tons, made up of 45 steel hopper cars, speeds of 20, 22 and 24 miles per hour have been maintained over the grades of 19 ft. per mile. This service has been so satisfactory that the company has now ordered 24 more locomotives of the same type.

In general the design of the locomotive follows the standards of the builders, which have been very thoroughly illustrated in these columns. In two respects, however, new features are introduced, this being particularly evident in the boiler, where a combustion chamber 6½ ft. long is incorporated. Other boilers have had combustion chambers, but so far our records show none of this size. By the incorporation of this construction it has been possible to bring the firebox back of the rear driving wheels, allowing a good depth of throat sheet being obtained without seriously interfering with the weight distribution. Ahead of the combustion chamber are flues 24 ft. long, which makes 30 ft. 6 in. from the fire box to the front tube sheet. A water space of 9 in. has been allowed between the combustion chamber and the shell of the boiler, to which it is stayed by radial staybolts. A baffle plate and tube support is located 7 ft. back of the front tube sheet, which prevents these very long tubes from vibrating to an excessive degree. This construction has been used in previous boilers designed by this company and illustrated in these columns.

Another departure from previous practice is noticed in the use of outside bearing radial trailing trucks, which are of a design similar to that used on the Pacific type locomotives. This arrangement gives a wider supporting base at the rear of the locomotive and tends to add decidedly to its stability. The leading truck is of the usual swinging bolster type.

That portion of the locomotive carried by the front group of wheels is supported by two sliding bearings, both of which are normally under load. The bolts connecting the upper rails of the front frames with the lower rails of the rear group are provided with a coiled spring under the nut at the lower end, as has previously been used by these builders.

The general dimensions of the sample locomotive are as follows:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	82,000 lbs.
Weight in working order	392,000 lbs.
Weight on drivers	324,000 lbs.
Weight of engine and tender in working order	555,200 lbs.
Wheel base, driving	10 ft.
Wheel base, total	48 ft. 3 in.
Wheel base, engine and tender	80 ft.
RATIOS.	
Weight on drivers ÷ tractive effort	3.96
Total weight ÷ tractive effort	4.78
Tractive effort × diam. drivers ÷ heating surface	763.00
Total heating surface ÷ grate area	83.40
Firebox heating surface ÷ total heating surface, %	6.10
Weight on drivers ÷ total heating surface	54.00
Total weight ÷ total heating surface	65.30
Volume equivalent simple cylinders, cu. ft	21.80
Total heating surface ÷ vol. equiv. cylinders	276.00
Grate area ÷ vol. equiv. cylinders	3.31
CYLINDERS.	
Kind	Mellin Comp.
Diameter	22 and 35 in.
Stroke	32 in.
VALVES.	
Kind, H. P	Piston
Kind, L. P	Slide
Greatest travel	6 in.
Outside lap, H. P	1 in.
Outside lap, L. P	⅞ in.
Inside clearance	5/16 in.
Lead in full gear	3/16 in.
WHEELS.	
Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	9½ x 13 in.
Driving journals, others, diameter and length	9 x 13 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	5½ x 10 in.
Trailing truck wheels, diameter	44 in.
Trailing truck, journals	7½ x 14 in.
BOILER.	
Style	Conical
Working pressure	225 lbs.
Outside diameter of first ring	83⅞ in.
Firebox, length and width	108¼ x 96⅛ in.
Firebox plates, thickness	7/16, 9/16, ⅜ in.
Firebox, water space	F. 5 in., S. & B. 4½ in.
Tubes, number and outside diameter	401—2¼ in.
Tubes, length	24 ft.
Tubes, material	Char. Iron
Heating surface, tubes	5,646 sq. ft.
Heating surface, firebox	367 sq. ft.
Heating surface, total	6,013 sq. ft.
Grate area	72.2 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	179 7/16 in.
TENDER.	
Tank	Water Bottom
Frame	13 in. Chan.
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	15 tons

Water Tube Fire Boxes for Locomotives

THE SUCCESS OF THE BROTAN BOILER IN FOREIGN COUNTRIES, GIVING OVER 14 PER CENT. FUEL ECONOMY, HAS RESULTED IN ATTRACTING GENERAL ATTENTION TOWARD THIS FORM OF CONSTRUCTION, AND MANY INSTALLATIONS ARE BEING MADE.

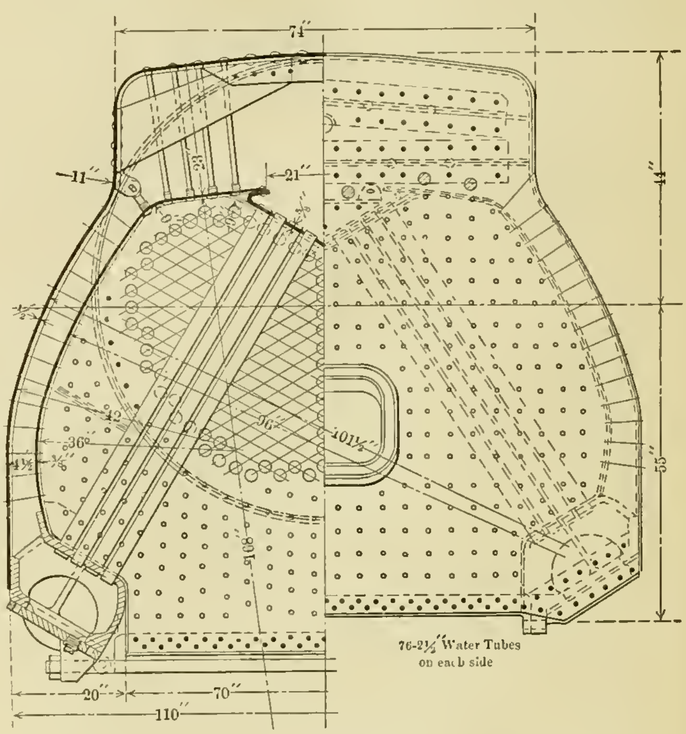
Water tube boilers, or properly water tube fireboxes, although never in receipt of much encouragement in this country, have not been an altogether unknown quantity. It is recalled that upwards of fifty years ago several engines so equipped were running regularly on the Philadelphia and Reading Ry., and it is to be regretted that through lack of proper appreciation they were quickly abandoned in favor of the much more common type which has now become standard in American practice. These early water tube fireboxes were quite similar to those which are now doing such good work in foreign countries, and had they been as painstakingly developed, there is no reason why the results should not have been equally gratifying.

This, it is believed, is the only instance of the water tube arrangement being actually put in service in America, although a number of patents have been granted on similar devices of more or less merit, none of which reached the point of attaining an actual existence. Some fifteen years ago William Forsyth, mechanical engineer of the C., B. & Q. R. R., proposed a water tube boiler of very substantial design, in fact differing only in detail from its successor of the present day. Unfortunately, this did not pass beyond the paper stage, despite its many plainly evident good features and the sound logical reasons which inspired it. The idea, however, clung with some persistency, and the years intervening since then have produced many creditable and a great many impracticable schemes, but all with the ultimate end in view to secure increased efficiency in steam production, with the minimum of complexity.

Probably the most prominent of these in the former class, and one worthy of special mention, is the water tube firebox designed and patented by S. S. Riegel, mechanical engineer of the Delaware, Lackawanna and Western R. R., in 1906,* which is herein illustrated. This was in reality a proposed re-design of a Southern Railway firebox of that period, to be secured through the substitution of a cast steel mud ring with water pockets cast in it, which ran parallel on either side with the grates. These pockets were intended to form the lower terminations for two nests of water tubes extending diagonally upward to the crown sheet, which latter was to be slightly depressed to keep the upper tube terminations flooded

This practical idea did not pass into working form, but its economy was thoroughly demonstrated through a most interesting model test which has been described and illustrated in this journal,† and which effectually substantiated all claims the inventor had originally advanced for his patent.

Notwithstanding, however, the general apathy exhibited in



SECTION OF A WATER TUBE FIREBOX DESIGNED BY S. S. REIGEL

this country toward this proposed change in boiler design, no deterrent influence was exerted on mechanical engineers of the old world. The versatility exhibited by these clever designers is well attested to in the patent reports of the various European

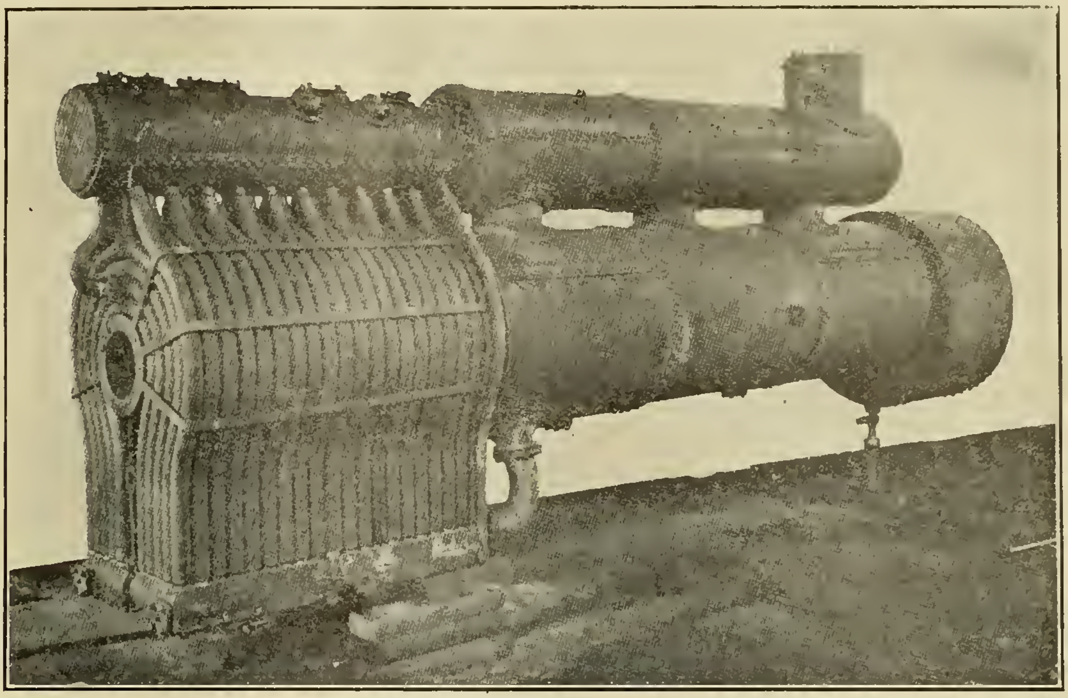
* See AMERICAN ENGINEER, April, 1906, page 136.

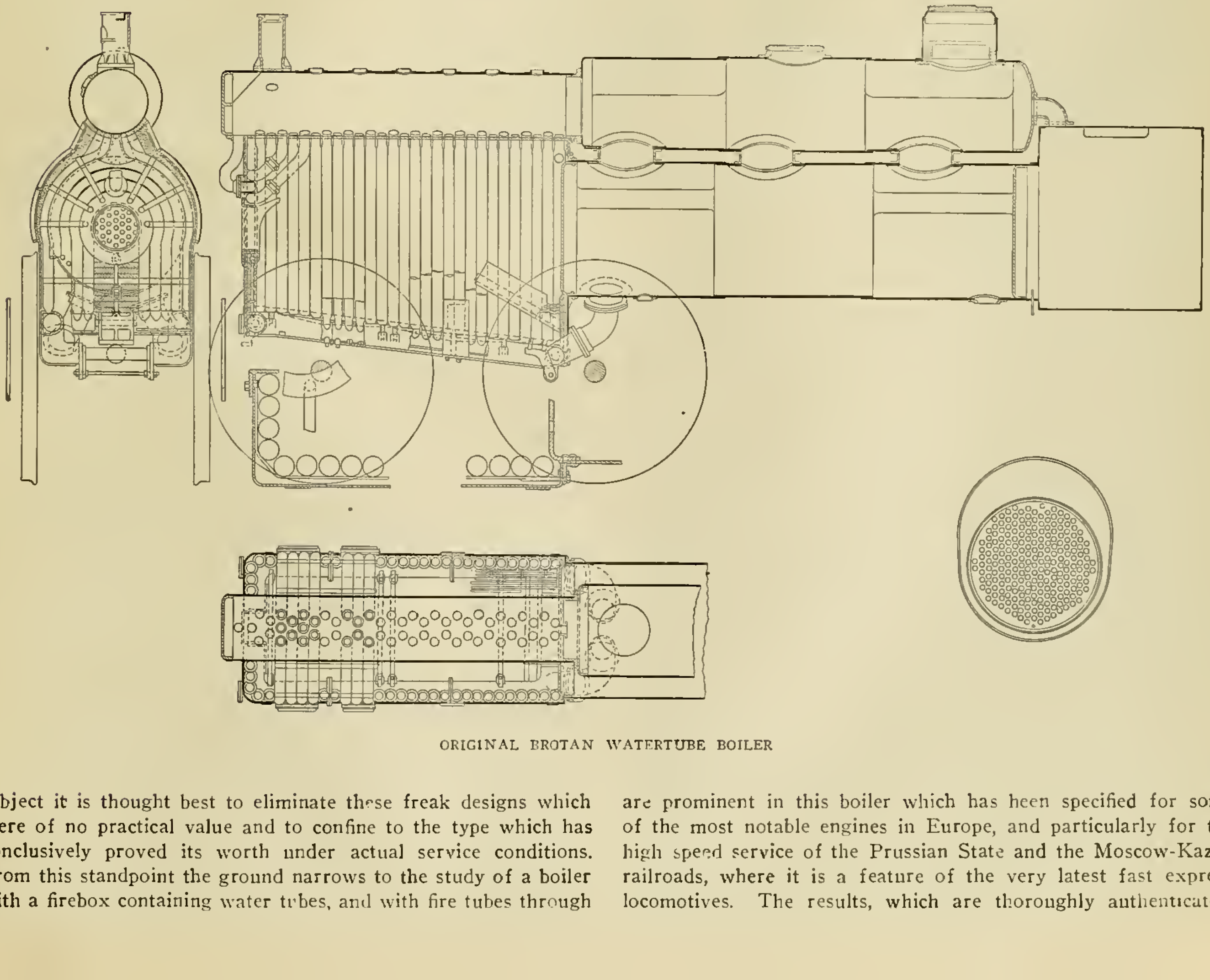
† See AMERICAN ENGINEER, June, 1909, page 253.

countries. A study of the majority of these devices carries no particular appeal, but it is an interesting fact that differing from the timidity so noticeable here, it appears that each new design was actually built and given a tryout, and this despite the fact that the greater number must appeal from a disinterested standpoint at least as utter absurdities.

Before attempting the full consideration of this now important subject it is thought best to eliminate these freak designs which were of no practical value and to confine to the type which has conclusively proved its worth under actual service conditions. From this standpoint the ground narrows to the study of a boiler with a firebox containing water tubes, and with fire tubes through the cylindrical portion, arranged in the manner with which we are familiar, or, in other words, a fire tube boiler with a water tube firebox. The Brotan boiler, therefore, which is being extensively installed in several European countries, becomes properly the subject for discussion as the most practical and efficient representative of the type.

It can no longer be disputed that certain points of superiority are prominent in this boiler which has been specified for some of the most notable engines in Europe, and particularly for the high speed service of the Prussian State and the Moscow-Kazan railroads, where it is a feature of the very latest fast express locomotives. The results, which are thoroughly authenticated,





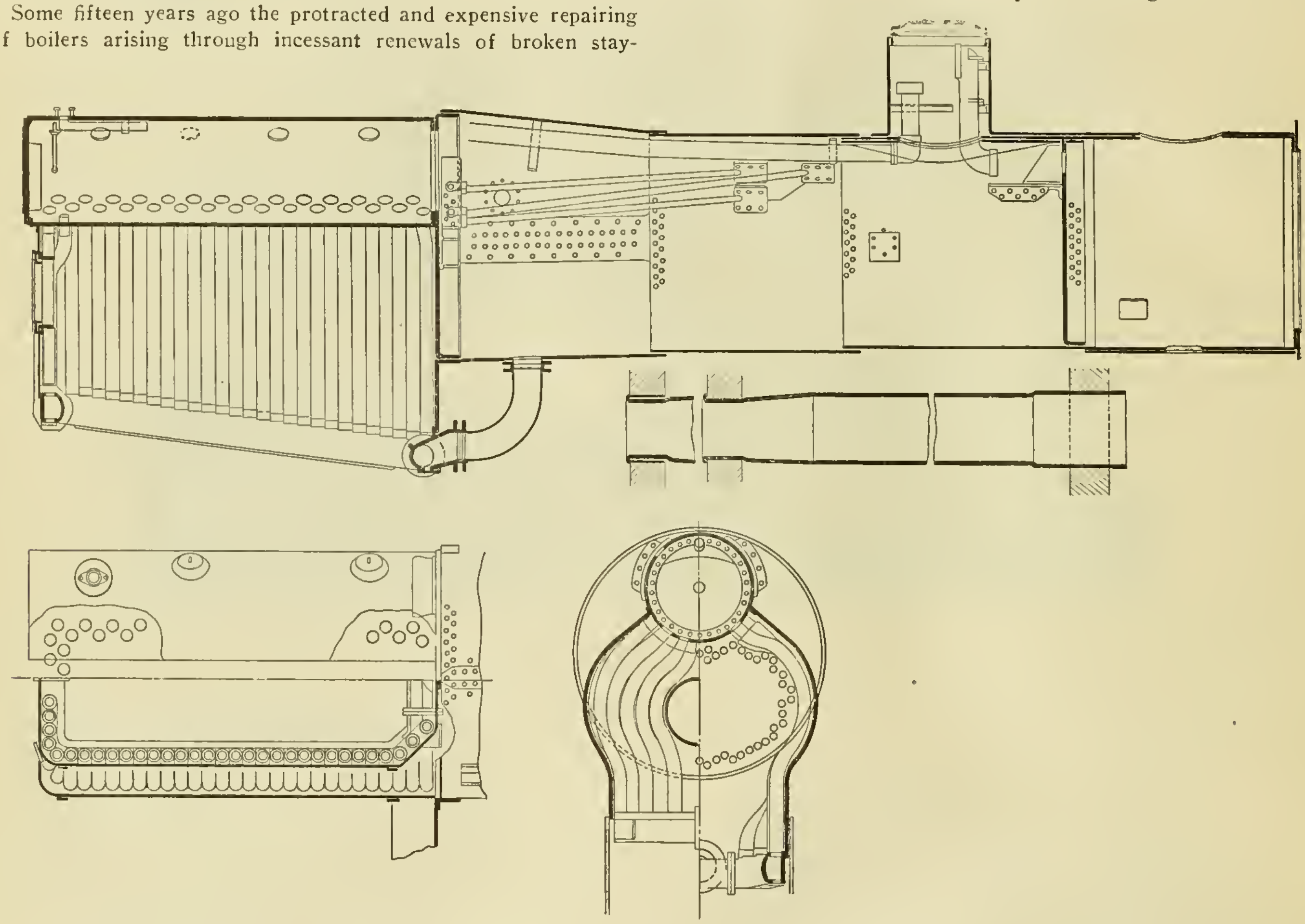
ORIGINAL BROTAN WATERTUBE BOILER

are gratifying to a degree, and the data presented is so convincing that it becomes inadvisable to avoid giving the subject serious consideration. While it may be conceded that the Brotan boiler is still in the experimental stage, it is, nevertheless, at a point where the fruits of the experiments may be profitably assumed in this country for further development. If this boiler will realize one-half the economy claimed for it by the Moscow-Kazan Ry., for instance, where repeated tests give 14.43 per cent. in coal consumption, a trial at least would appear as a logical necessity. The history of its introduction into foreign practice merits a brief mention.

Some fifteen years ago the protracted and expensive repairing of boilers arising through incessant renewals of broken staybolts and the impracticability of further increasing pressures through the liability of inducing further breakages were the principal features which led G. Noltein, member of the administration of the Moscow-Kazan Ry. of Russia, to consider the possibility of replacing the usual locomotive firebox by one of new type with water tubes and without staybolts. The experiments begun with this object in view, however, were not yet completed when chief inspector J. Brotan, works manager of the Austrian State Ry., brought forward his water tube firebox, which had been very carefully thought out and logically designed. This was entirely to the satisfaction of Mr. Noltein, as it made further work on his part unnecessary, and rendered it possible to proceed immediately to practical tests of a completed design which aimed at exactly the object which he had in view.

After the protracted formalities, which in Russia obstruct the introduction of anything new had been overcome, it became possible in 1904 to begin the construction of two experimental boilers for application to 0-8-0 freight locomotives. The general arrangement of these first boilers of the Brotan type, which are still in service, although lately the type has been subject to a re-design in which the upper barrel is eliminated, is clearly shown in the accompanying illustrations.

The foundation tube, which occupies the place of the foundation or mud ring in the ordinary construction, has as its chief function that of supplying water to the firebox water tubes, in order to replace from the barrel, with which it is connected by two large tubes, the water that is evaporated in the firebox tubes. The result is a very quick circulation, and this, it is claimed, makes it more difficult for scale to deposit even if hard water is used. Having a tube from the barrel at either front corner of the foundation tube has made it possible to avoid connecting both longitudinal sides of the foundation tube. This is an appreciable improvement, as experience has shown that the flange joints of the foundation tube are those points of the boiler where it is most difficult to prevent leakages.



BROTAN WATERTUBE BOILER AS APPLIED TO 2-8-0 TYPE SUPERHEATER LOCOMOTIVES ON THE MOSCOW-KAZAN RAILWAY

It will be noted that the firebox and firebox shell of the ordinary boiler have been replaced by vertical water tubes made of iron or steel, and extending from the common foundation ring to the upper drum. These tubes, which are spaced rather close, form the walls of the firebox and allow rapid circulation from the barrel to the upper drum. As the water enters the firebox water tubes from below steam rises very freely without forming vortices, and as the mixture of steam and water in the tubes has a materially lower specific gravity than the entering water, the circulation must be necessarily greatly facilitated. The quicker and more economic production of steam in the Brotan boiler can only be attributed to this feature, and to the greater direct heating surface which results from the circular cross section of the tubes and from their staggered arrangement on entering the receiver.

When the authorization was given for this construction several prominent engineers expressed misgivings that its maintenance would prove a serious problem, but in reality the cost of repairs has been less than in a boiler of ordinary design. After three years continuous service it was found that the few leaks which did develop were easy to remedy, and the only work required of any magnitude consisted in replacing one burnt water tube, which resulted from lack of care in washing out. A large number of pieces of scale had been allowed to accumulate in the foundation tube, and these obstructed the circulation in the tube which failed. Only one day was required by the shops to make these repairs.

It has been mentioned that the economy of 14.43 per cent. in coal consumption was attained by these engines on the Moscow-Kazan Ry., a figure so surprising that the administration of that road refused to accept the report from its statistical section until it had been checked by a number of carefully executed trial runs which extended throughout the entire month of April, 1909. The results were synonymous with those originally reported on, and the administration thereupon decided to equip fifteen superheated steam passenger locomotives of the 2-8-0 type with Brotan boilers.

These differ somewhat in appearance from the original design, as shown in the drawing of the boiler. The upper drum has been eliminated, and the back ring of the boiler coned. This change, which provides a much larger water surface, and at the same time a sufficiently large steam space, has served to overcome the trouble of wet steam which was present in the former type to a certain extent. With this exception, and that the number of fire tubes has been increased from 208 to 230, the design remains the same as originally produced. The firebox has the usual arrangement of grates and brick arch, and is intended to work at a pressure of 210 pounds.

Among the locomotives with Brotan boilers on other Russian lines it is necessary to mention two 0-8-0 freight locomotives, Nos. 675 and 708, which have been running on the South Eastern Ry. since December, 1907. The design of the boilers of these locomotives is that of the original Brotan type, the only difference being that the connection between the foundation tube and the barrel of the boiler consists of one instead of two tubes, and which has a diameter of 7 15/16 in. The chief particulars of these boilers is as follows:

Working pressure	185 pounds
Tubes, number and outside diameter	208—2 in.
Tubes, length	14 ft. 7 5/16 in.
Heating surface, tubes	1,440 sq. ft.
Heating surface, firebox	163 sq. ft.
Heating surface, total	1,603 sq. ft.
Grate area	20.8 sq. ft.
Weight of boiler empty	29,000 lbs.

These two locomotives were at first used in a district where the feed water has a hardness of 13 to 17 degrees. The trains weigh about 700 tons in summer and 640 tons in winter, weight of locomotive and tender included. In November, 1908, they were transferred to another district on which conditions were less favorable, with heavier grades and feed water with a hardness of 20 to 35 degrees.

Working under these conditions the locomotives have given excellent results in every respect. That they are very economical with coal as compared with the ordinary boiler is shown by the following tabulation:

	Coal consumed in lbs.	Miles run.	Coal consumed in lbs. per locomotive mile.
Brotan boiler locomotives	3,092,360	30,271	69.12
Other locomotives	11,621,390	136,431	85.18

The saving in coal in the locomotives with Brotan boilers is accordingly:

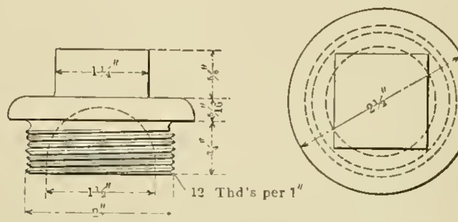
$$(85.18 - 69.12) \div 85.18 = 18.87 \text{ per cent.}$$

It should be added, however, that the administration of the South Eastern Ry. does not attribute this coal economy solely to the feature of the Brotan boiler, for the two locomotives were at the time of that installation improved in other ways. The Joy valve gear of the Russian standard 0-8-0 freight locomotives was replaced by Heusinger valve gear, and the ordinary flat slide valves by balanced slide valves of the von Borries type. The railway, on the basis of other experiments, attributes a coal economy of 9 to 10 per cent. to these alterations in design, which leave an economy of from 9 to 10 per cent. in favor of the Brotan boiler. In view of the minimum of trouble which it has experienced with this type the South Eastern Ry. will adopt the Brotan as standard in some service.

At the present time, so far as can be learned, the total number of these boilers now in service in European countries is 71, distributed throughout all classes of service, but inclining particularly toward fast passenger work, where free steaming qualities are particularly to be desired. The management of the railroads where the boiler has been tried out have no hesitation in saying that they are perfectly willing to install it as a permanent institution, but its introduction must necessarily proceed slowly in view of the fact that government approval must be secured in the majority of those countries where standards are changed on evenly privately owned roads.

GREASE LUBRICATION

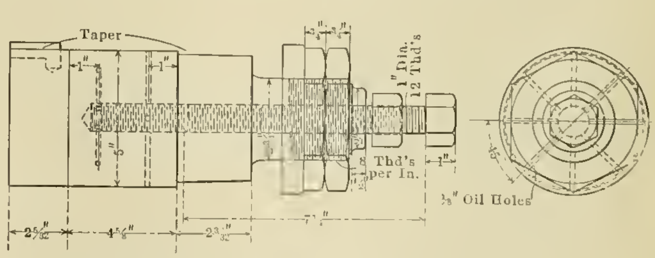
Experience with grease cups on main and side rods, on some roads, indicates that the usual screw plug for forcing the grease out of the cup is not necessary and that by using the proper lubricant the warmth of the pin itself will cause sufficient lubrication. This not only is a great saving in the amount of grease used, but also simplifies the construction of the cup itself and makes it decidedly less expensive. On the back end of main rods, however, the centrifugal action makes it very difficult to



CAP FOR GREASE CUP ON MAIN AND SIDE RODS

keep even a simple cap on the grease cup and considerable annoyance has been caused by these caps constantly being lost, which not only is an expense, even if they are made of malleable or cast iron, but also gives an opportunity for cinders and dirt to get to the pin.

A cap has been designed in the mechanical engineer's office of the Atchison, Topeka & Santa Fe Railway which has proven a decided success in this regard, probably due to the size of the collar that bears on top of the cup and the depth of the thread. It will be noticed in the illustration that this cap is hollowed out in the centre and when it is applied, after a new filling of the



CROSSHEAD PIN ARRANGED TO USE GREASE LUBRICATION

cup, it forces sufficient grease on to the pin to thoroughly lubricate it at the start.

In the same office a grease lubricator for cross head pins has also been designed. This, as will be seen in the illustration, consists of a hole in the centre of a pin threaded to receive a 1 in. bolt. From this four ⅛ in. holes lead to the bearing surface, as shown. Grease in suitable shape is inserted in the hole and the bolt used for a plunger in the customary manner. While this construction is not suitable for the inside cross heads of four-cylinder locomotives, it offers no obstruction in outside cylinders. With Walschaert valve gear the relative position of the cross head pin and combination lever is such that they never interfere.

GRAND TRUNK PACIFIC TO REACH COAST IN 1913.—After completing his inspection of the Grand Trunk Pacific to the end of its track, 200 miles west of Ebenton, E. J. Chamberlain, vice-president and general manager of that road, has expressed an opinion that through train service would be established from Bonaventure to the Rocky Mountains by 1912, and a year later to the Pacific Coast.

REVISED SPECIFICATIONS FOR STAYBOLT IRON

At the recent convention of the American Society for Testing Materials the Committee on Standard Specifications submitted a revised specification for staybolt iron, which under the rules goes over for one year. The changes consist of the following: The addition to the first sentence of the words, "the basis of which must be pig metal and entirely free from any admixture of steel"; and the omission of the following matter: "the pile must be made up of a central core composed of bars from ½ inch to 1 inch square, and be covered on all four sides with an envelope ⅝ inch thick, as per sketch. This pile must be rolled to a billet, allowed to cool, again heated and then rolled into bars of the required dimensions." The proposed changes also include the substitution of a nick and bend test for the threading test.

The revised specification is as follows:

PROPOSED STANDARD SPECIFICATIONS FOR STAYBOLT IRON.

Process of Manufacture.

All staybolt iron must be hammered or rolled from a bloom or a box-pile having a cross-sectional area of at least 45 sq. in., and not less than 18 in. long, the basis of which must be pig metal and entirely free from any admixture of steel.

Physical Tests.

(*a*) Tensile Strength.—Not less than 48,000 lb. per square inch.

(*b*) Elongation.—Not less than 28 per cent. in 8 in.

(*c*) Reduction of Area.—Not less than 45 per cent.

(*d*) Double Bending Test.—Close in both directions without flaws.

(*e*) Nick and Break Test.—A bar, nicked all around to a depth not less than 8 per cent. and not more than 16 per cent. of the diameter of the bar, and broken, shall show a clean fiber entirely free from crystallization.

(*f*) Vibration Test.—The test bar shall stand a minimum of 6,000 revolutions when subjected to the following vibratory test:

A threaded specimen, fixed at one end, has the other end moved in a circular path while stressed with a tensile load of 4,000 lb. The circle described shall have a radius of 3-32 in. at a point 8 in. from the fixed end of the specimen.

Inspection.

(*a*) The iron must be smoothly rolled and free from slivers, depressions, seams, crop ends and evidences of being burnt.

(*b*) It must be truly round within 0.01 in. and must not be more than 0.005 in. above or more than 0.01 in. below specified sizes.

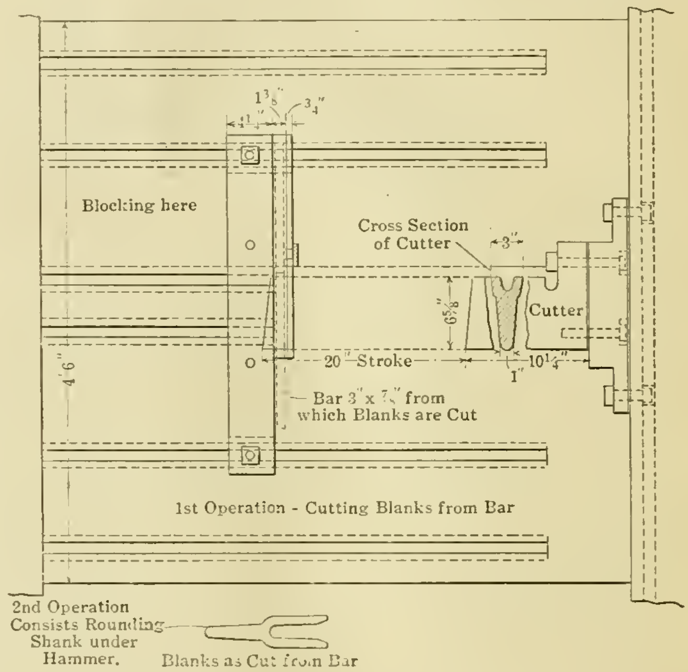
Selection of Samples for Test.

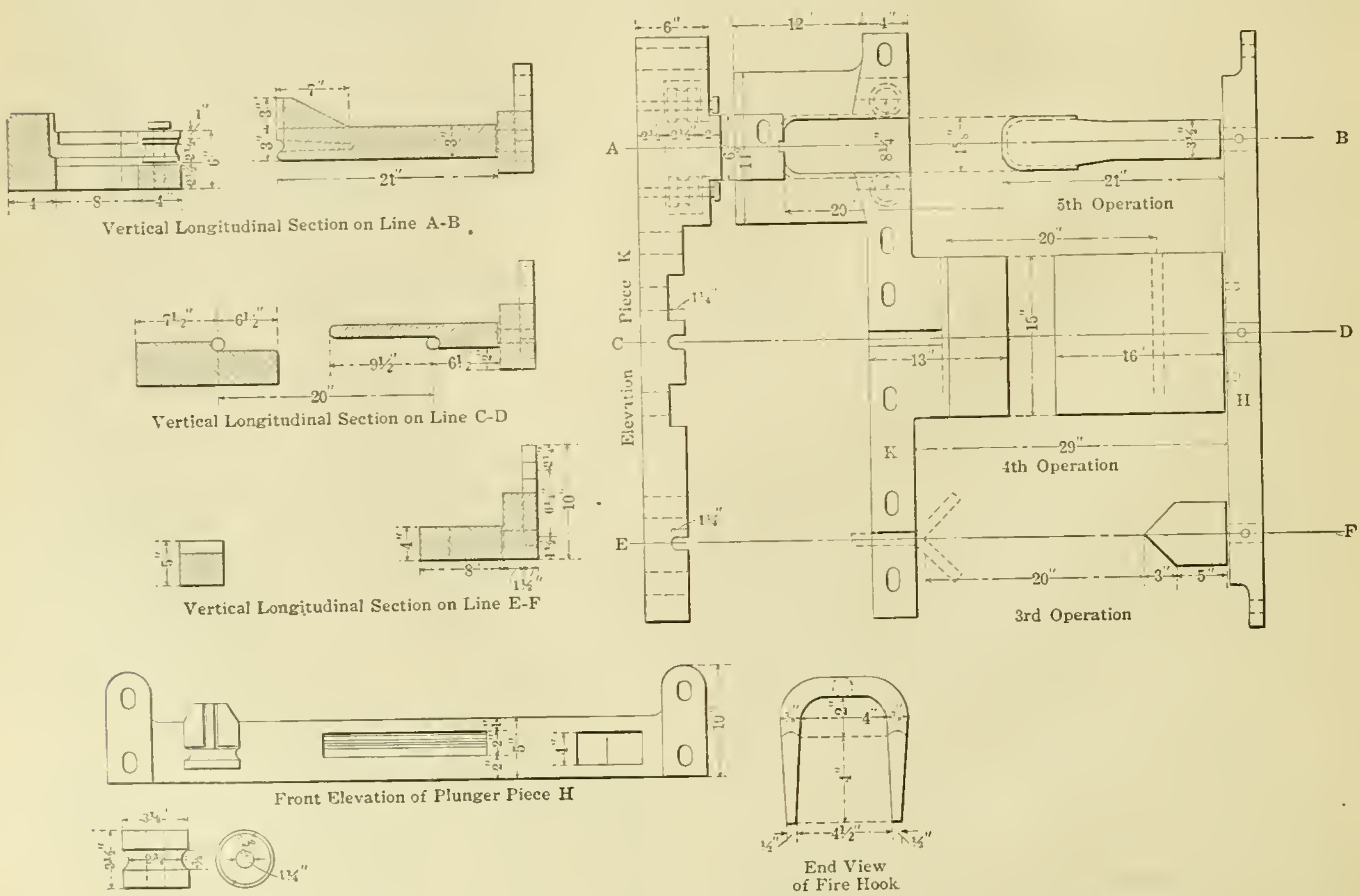
The bars will be sorted into lots of 100 bars each and two bars will be selected at random from each pile. Failure of either of these bars to meet any of the above specifications will be cause for rejection of the lot which the tests represent.

MAKING FIRE HOOKS ON A BULLDOZER.

Geo. H. Roberts.

At the Readville shops of the New York, New Haven and Hartford R. R. formers have been designed for making two-

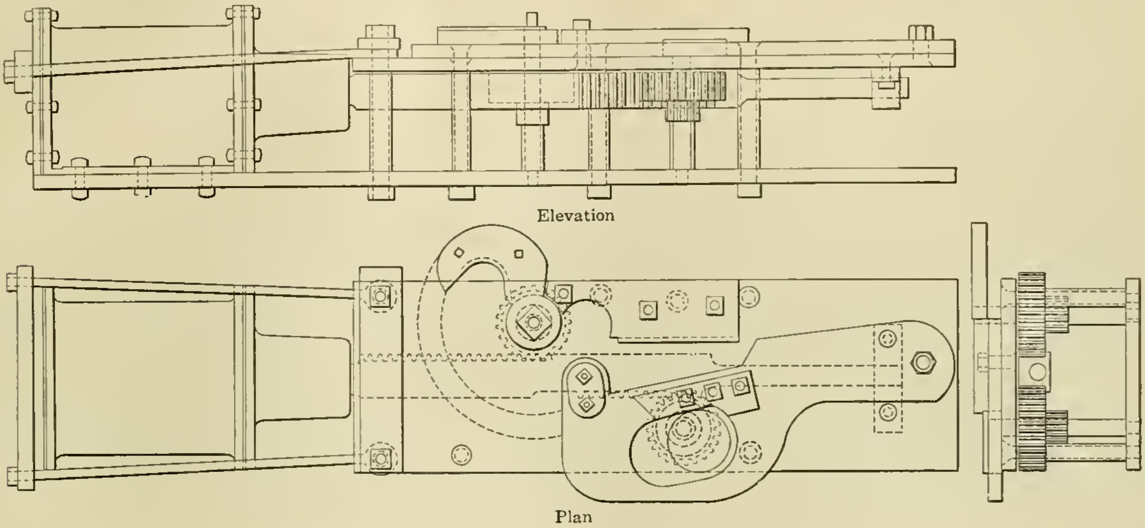




FORMERS AND ARRANGEMENT FOR THE FIVE OPERATIONS IN MAKING THE PRONGS ON FIRE HOOKS pronged fire hooks on the bulldozer which will turn out 500 hooks in nine hours, two men working, and 200 handles per hour, two men working. Welding the hooks on the handles is done separately.

The formers used are shown in the illustrations. But one operation is required for making the handles, a very ingenious use of rack operating gears and an eccentric cam to give the proper movement to suitably shaped heads employed. The rack is connected to the piston of a 10-inch air cylinder. The movement of the formers will be evident from a study of the illustration.

Five operations are required in making the hooks. They are all done with but two heats, however. The first operation consists of punching blanks of the shape shown out of ⅞ x 3-inch stock. It will be seen that there is very little waste of material in this operation. The shank of the blank is rounded under a hammer during the same heat, this being the second operation. The piece is then reheated and the third operation consists of spreading the jaws apart as shown by the dotted lines. It is then transferred to the next set of dies where it is formed into T shape and the prongs rounded at the proper taper. The fifth and last operation consists of bending the prongs to the shape shown in the end view of the hook and at right angles with the shank. The last three operations are performed on one machine and with one heat.



FORMERS FOR BENDING THE HANDLE OF FIRE HOOKS

SIXTY MILLION DOLLARS EXPENDED FOR CROSSTIES IN 1909

The Census Bureau, in conjunction with the Forest Service of the Department of Agriculture, annually collects and publishes a special report relative to the consumption of cross-ties. This information has just appeared in a preliminary comparative report covering 1909, 1908 and 1907, and it indicates an enormous increase, fully 10 per cent., in the number of wooden cross-ties purchased for consumption by the steam and electric railroads in the United States in the calendar year 1909, as compared with the number purchased in 1908.

In 1909 the total number of cross-ties of all kinds of wood, reported as having been purchased, was 123,754,000, costing $60,321,000 at the point of purchase, as compared with 112,463,000, costing $56,281,000, in 1908, and 153,700,000, costing $78,959,000, in 1907. The latter year does not, however, represent the true standard of comparison, as it was one of unusual railroad development. The decrease in 1908 was about 26.8 per cent., but in 1909 the balance swung back to 80.5 per cent. of the 1907 record, and was, as stated, an increase of about 10 per cent. over 1908.

A significant feature is the fact that in 1909 there were 16,437,000 cross-ties reported as purchased for new tracks, against 7,431,000 in 1908, and 23,557,000 in 1907. The amount expended for ties by the steam and electric railroads in 1909 amounted to $60,000,000. The purchases by steam railroads formed about 93 per cent. of the total in 1909 as compared with approximately 94 per cent. in both 1908 and 1907. While there was considerable variation in the number of cross-ties purchased during the three years, the average cost per tie remained close to 50 cents.

THE ALL-IMPORTANT ROUNDHOUSE.—There are about 60,000 locomotives in the United States and their cost of maintenance is approximately $2,500 each per year, or a total for all of $150,000,000. About one-half of this work, amounting to $75,000,0000 is done in the roundhouse. In addition to this running repair work the roundhouse organization is required to perform such service work as may be necessary, including the movement of engines, the washing of boilers and tanks, the cleaning of flues, firing up, and coaling, sanding and watering, etc. The cost of this service varies between wide limits, and averages something over $1.50 per engine, or approximately $500 a year for each engine owned. This adds about $30,000,000 to the amount expended in roundhouses and makes a total of $105,000,000.—*F. H. Clark, at the University of Illinois.*

NOT FAVORABLE TO MAIN LINE ELECTRIFICATION.—The case of entirely new railways is much more favorable to electrical operation. In laying out a new branch to an existing railway, it may be well worth while to consider electrical operation, the capital cost of which might be more than saved in the cheaper roadbed, since steep grades are much less objectionable on an electrical than on a steam road. Of course, there are likely openings for local electrification on existing railways even apart from suburban systems. It might, for instance, be found profitable to work the pushers on the inclines electrically. It is quite possible, again, that where electric power is already available at goods yards and docks, the shunting could be more efficiently carried out by specially designed electric locomotives, fed perhaps by a suitable surface-contact system, than by steam locomotives, that would seem to be uneconomical for such work. For ordinary main-line work, however, there is at present no indication that the steam locomotive can be superseded with advantage in this country.—*W. F. W. Carter, of Rugby, England, before the Institution of Mechanical Engineers.*

A NEW USE FOR ELECTRIC WELDING is described in the engineering supplement of the London *Times* of September 14, 1910. A steel chimney 56 ft. high and 4 ft. 3 in. in diameter, was put together entirely by electric welding, and was completed before erection. It was erected in about three hours.

Heavy Power for the Hocking Valley Ry.

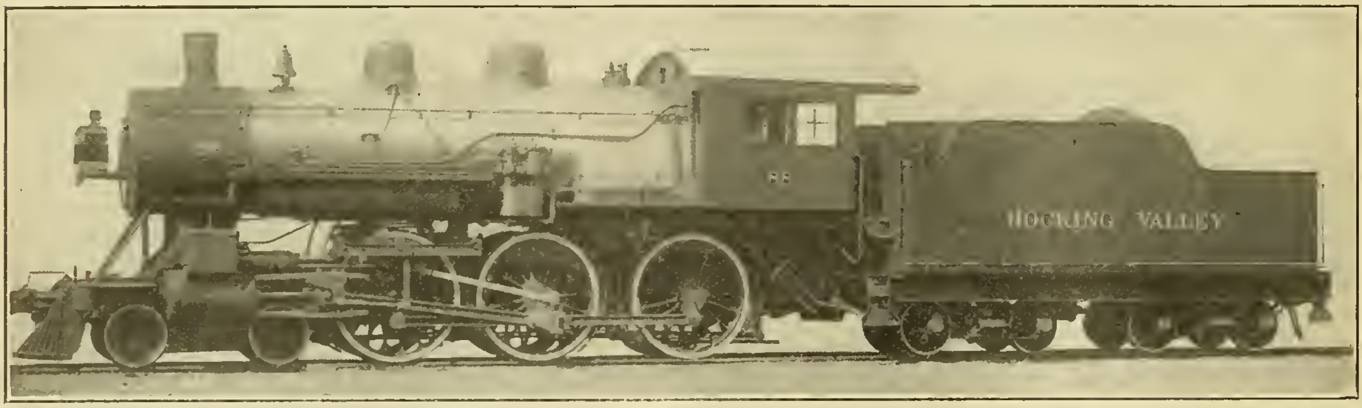
A RECOGNITION OF THE VALUE PERTAINING TO THE OPERATION OF HEAVY TRAIN UNITS HAS BEEN ACCORDED BY THIS COMPANY IN SUPERSEDING ITS FORMER LOCOMOTIVES WITH OTHERS OF PRACTICALLY DOUBLE CAPACITY

With a view to ultimately replacing its light power, in both freight and passenger service, the Hocking Valley Ry. has recently received twenty freight and three passenger engines from the American Locomotive Company. These were designed by the late G. J. DeVilbiss, superintendent of motive power of that line, and represent many departures from the former practices of this road.

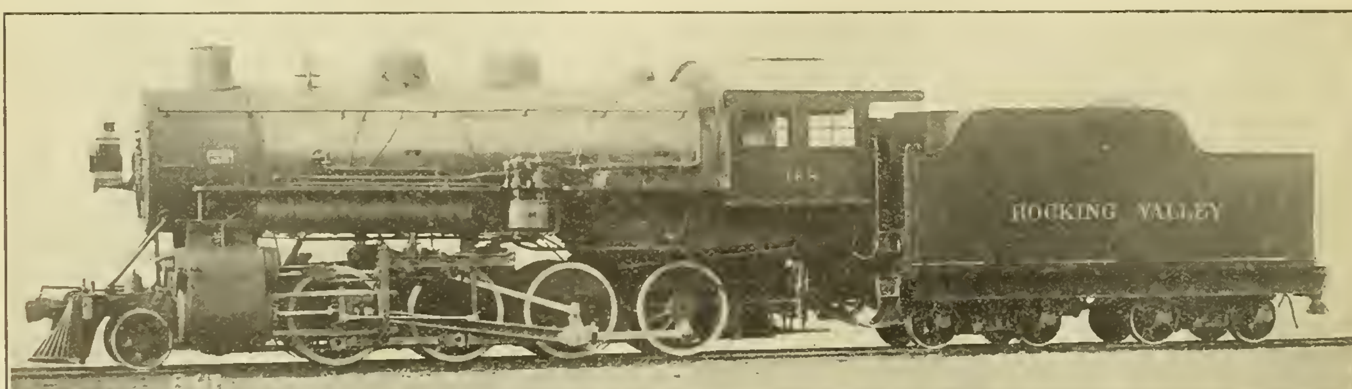
For instance, the heaviest freight type heretofore used has total weight of 164,000 lbs., with 20 x 26 in. cylinders, 180 lbs. steam pressure, 54 in. drivers, maximum tractive effort, 29,400 lbs., and hauling capacity 2,400 tons. The new engines weigh 236,000 lbs., with 23 by 30 in. cylinders, 205 lbs. steam pressure, 57 in. drivers, and a maximum tractive effort of 48,500 lbs. They are capable of hauling 4,800 tons over 3 per cent. grades. The same considerable difference is noticeable in the passenger engines, which are of the 4-6-0 type, and of heavy design to handle 6 to 10 cars on a fast schedule, with stop averaging five miles apart. They weigh 188,000 lbs., with 20 by 26 in. cylinders, 200 lbs. boiler pressure, 72 in. drivers, and maximum tractive power of 24,500 lbs., as against the previous largest passenger engines weighing 141,000 lbs., with 18 by 26 in. cylinders, 180 lbs. pressure, 66 in. drivers, and 19,500 tractive power.

The boilers of both types are radial stayed extended wagon top, a departure from the Belpaire, which has heretofore been standard on that line. Tube heating surface has been somewhat sacrificed in square spacing, but there is a large amount of firebox surface, especially in the passenger engines. Flexible staybolts have been used to a large extent. The fire doors are pneumatic, and ash-pans are Hocking Valley standard drop bottom, which have been adopted by several leading railroads.

All of the engines are equipped with Baker-Pilliod valve gear the passenger engines and ten freight engines having slide valves and the other ten with piston valves. The frames on the freight engines are Vanadium cast steel, and the driving springs on both engines are of the same material. The shoes and wedges are of bronze working on cast steel boxes. All cylinders are bushed with gun iron, and the pistons of the solid-head type have gun iron packing rings. The tenders have tanks of the water bottom type, set on steel trusses of 13 in. channels, and the trucks are of the arch bar type, with cast steel bolsters and cast steel wheels.



NEW TEN WHEEL LOCOMOTIVE FOR THE HOCKING VALLEY RY.



NEW, POWERFUL CONSOLIDATION LOCOMOTIVE FOR THE HOCKING VALLEY RY.

As indicated in the accompanying illustrations the engines, particularly the freight type, are of a strikingly handsome and compact design. The general dimensions and ratios are as follows:

GENERAL DATA.

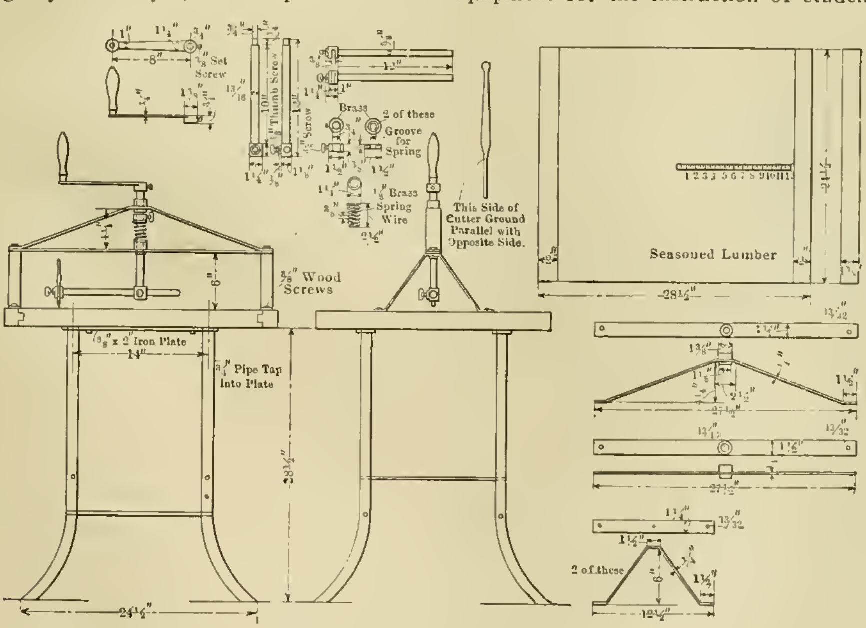
	Freight	Passenger
Tractive effort	48,500 lbs.	24,500 lbs.
Weight in working order	236,000 lbs.	188,650 lbs.
Weight on drivers	208,000 lbs.	142,000 lbs.
Weight of engine and tender in working order	390,000 lbs.	332,000 lbs.
Wheel base, driving	17 ft. 3 in.	14 ft. 4 in.
Wheel base, total	26 ft. 5 in.	26 ft. 1 in.
Wheel base, engine and tender	58 ft. 3 in.	56 ft. 6 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.29	5.79

Total weight ÷ tractive effort	4.87	7.67
Tractive effort × diam. drivers ÷ heating surface	783.14	707.01
Total heating surface ÷ gate area	64.18	47,98
Firebox heating surface ÷ total heating surface, %	5.72	6.81
Weight on drivers ÷ total heating surface	58.92	56.91
Total weight ÷ total heating surface	66.86	75.35
Volume both cylinders, cu. ft	14.42	9.45
Total heating surface ÷ volume cylinders	244.80	264.02
Grate area ÷ volume cylinders	3.81	5.50
CYLINDERS.		
Kind	Simple	Simple
Diameter and stroke	23 by 30 in.	20 by 26 in.
VALVES.		
Kind, on ten engines	14-in. piston	——
Kind, on others	Slide	Slide
Greatest travel, piston	5 in.	——
Greatest travel, slide	5¼ in.	5¾ in.
Outside lap	1 in.	1 in.
Inside clearance	Line and line	1/16 in.
WHEELS.		
Driving, diameter over tires	57 in.	72 in.
Driving, diameter centers	50 in.	66 in.
Driving journals, main, diameter and length	10½ x 12	9 x 12
Driving journals, others, diameter and length	10 x 12	9 x 12
Engine truck wheels, kind	Cast steel	Cast steel
Engine truck wheels, diameter	33 in.	33 in.
Engine truck journals, diam. and length	6 x 12	5½ x 12
BOILER.		
Type	E. W. T.	E. W. T.
Working pressure	205 lbs.	200 lbs.
Outside diameter first ring	80 in.	67 in.
Firebox, length and width	73¼ x 108⅛	73¼ x 102¼
Firebox, thickness of plates	⅜ and ½	⅜ and ½
Firebox, water space	5 in.	5 in.
Tubes, number and outside diameter	412—2 in.	291—2 in.
Tubes, length	15 ft. 6 in.	15 ft. 4 in.
Heating surface, tubes	3,328 sq. ft.	2,325 sq. ft.
Heating surface, firebox	202 sq. ft.	170 sq. ft.
Heating surface, total	3,530 sq. ft.	2,495 sq. ft.
Grate area	55 sq. ft.	52 sq. ft.
TENDER.		
Tank, type	Water Btm.	Water Btm.
Frame	13-in. channels	13 in. channels
Wheels, diameter	33 in.	33 in.
Wheels, kind	Cast steel	Cast steel
Journals, diameter and length	5½ x 10	5½ x 10
Water capacity	7,500 gals.	7,000 gals.
Coal capacity	16 tons	13 tons

AN EFFICIENT HOME-MADE GLASS CUTTER

The comparatively simple matter of cutting a new headlight glass becomes quite frequently a very perplexing operation, especially when it is an emergency or rush job, and no special devices exist for the purpose. It is not at all uncommon under such conditions to see a dozen plates wasted in crude attempts to secure the necessary circular shape, and with little assurance that it will fit when finally produced. It is to dismiss these unpleasant features that the Chicago and North Western Ry. has designed a very cheap and efficient circular glass cutter, which is now in successful use in its various shops.

The simplicity of the device is clearly indicated in the accompanying drawing. The frame, or base, is made from ¾ in. pipe, on the top of which is fastened a board, scaled in inches, and which allows the cutter to be set at the required radius. A common ten cent cutter is used, held in place by a set screw. The coil spring is intended to hold the cutter up from the board to admit the work. This very handy little cutter will take care of circular glass from one inch to the largest headlight size of 24 inches in diameter.



HOME-MADE GLASS CUTTER

GETTING SUGGESTIONS FROM THE MEN

The American Locomotive Company is experimenting in its Rogers works at Paterson, N. J., with the plan of paying weekly prizes to its employees for the best suggestions tending toward improvement in existing shop methods. This innovation has awakened the liveliest interest among the men, and since its introduction there has been no lack of competitors. The idea is particularly appealing to those who feel that they know of a good thing, and who ordinarily would have no other way to present it than by dropping the idea into the suggestion box.

While, as might be expected, some of the descriptions and sketches submitted have been found to be crude and poorly executed, practically no consideration is accorded this feature by the judges in awarding the prizes; what is wanted is a new, practical idea, and the intention is to develop all such which appear to be of value.

NEW BUILDING AT PURDUE UNIVERSITY.—On November 12 new buildings for the department of practical mechanics at Purdue University were dedicated. The main building occupies about 25,000 sq. ft. of floor space and will accommodate 400 students at one time for drawing instruction, and in addition the shops, covering 43,000 sq. ft. of ground, will accommodate 350 students. There are also class rooms, lecture rooms, offices, a museum, etc. This constitutes what is to be the largest and most complete equipment for the instruction of students in shop practices and drawing in this country. The tools and other equipment in the shop are modern in every way and many unique and special features have been installed.

THE RECORDS OF 80 ENGINES on the Great Western R. R. of England, fitted with the "Swindon" superheater, for the five summer months ended 10th of September, show an all-around saving of coal of 12½ per cent. and from 25 to 30 per cent. of water.

[ESTABLISHED 1832]
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CONTRIBUTIONS—Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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FROM APPREHENSION TO SECURITY

The Railway Business Association, although but in the third year of its existence, has nevertheless become a significant and recognized factor in some underlying and less understood features which have a vital bearing on the profitable and successful conduct of railroad operation. Proceeding without ostentation, and with little publicity, it has accomplished much of what was intended, and it is not difficult to trace its effectiveness in the abatement of much prejudice and misapprehension which could not prove other than deterrent to railroad enterprises at large.

That such sentiment did and does exist is evinced by the presence of this friendly Association in its dual rôle, both conciliatory and mediatory. Its inauguration was in fact a recognition of the general railroad plea of too heavy burdens imposed through ill-advised legislation, and of haphazard criticism without investigation. The Association fully appreciated that when the railroads stopped making money, few branches of business would remain unaffected, and furthermore they believed in the honesty of the manifestations by the railroads, coupled with the knowledge that the latter are not so black as had been painstakingly painted.

The recent annual dinner of the Association may be regarded with particular significance because it brought together the representatives of the railroads; those who use them, and the Interstate Commerce Commission, which has much to say in regard to how the various commodities shall be carried. A favorable business outlook for the future may well be argued from the friendly and co-operative spirit reflected in the addresses of Messrs. Willard, Knapp and Claflin. In uniting these powerful instruments for common good on a middle ground the Association in that alone performed a signal achievement.

Mr. Willard asked only that the railroads be allowed to remain unhampered, for a time at least, until certain problems could be solved; Mr. Knapp conceded that the railroads should not be deprived of their earnings to the extent that new capital could not be attracted, or proper improvements made, and Mr. Claflin frankly admitted that some increase in freight rates would be justified to permit the railroads to make these improvements and extensions, which would ultimately help the general situation through the increased business that would logically follow.

It is believed that an increased feeling of security will follow this gathering. But this is not the least important of the work which the Railway Business Association has elected to perform, which fortunately it is even now in a fair way toward realization. Public misconception of railroads, so much in evidence two or three years ago, which arose largely through ignorance of the fact, is fast disappearing. It needed but the advent of this unique organization, composed of the very men who annually pay enormous sums in freight rates to necessarily produce a reversion in former inimical sentiment, and especially when as the most interested body it arose in defense of the railroads.

Through this the Association has done and will continue to do great good. That it will relieve the maligned railroads of this portion of their burden at least is confidentially believed and increased prosperity will inevitably follow the restoration of confidence.

THE BROTAN WATER TUBE BOILER

Although the Brotan boiler, so called, which forms the basis of an article in this issue, embodies points in construction at variance with American ideas, it nevertheless merits a careful study in view of its possibility as the solution of a problem which necessarily become more vexatious with the passage of time. The desirability for employing higher steam pressures is generally recognized, but there is an ever present barrier to its accomplishment in the shape of increased failures of stay-bolts and braces, which must inevitably follow should the increase be attempted in the instance of boilers of the ordinary design.

The absence of these parts, which have become so generally associated with trouble, really constitutes the appeal of this novel but decidedly practical arrangement. The Brotan boiler has no firebox sheets to crack or groove, no crown sheet; and, consequently, no roof bolts and no staybolts. As defective conditions of these parts are responsible for the majority of damages to boilers, a decidedly safer construction becomes herein at once apparent, with the elimination from further consideration of time-honored items of maintenance expense.

The system of construction is strong, and there are no particular obstacles to efficient up-keep. Observations extending over three years or more have shown conclusively that the maintenance cost has been very much less than with boilers of the ordinary type. They give good results, both in steam production and in keeping up pressure, and their first cost is some 20 per cent. less than a boiler of the common form.

Doubt has been expressed in some quarters regarding the reliability of the figures issued from the roads where the Brotan boiler is in service covering its economical features, but this need not be entertained in the slightest degree. The strict government supervision of railroads in those countries insures accuracy in all data returned to the government, and it is interesting in this connection to note that the report on the Brotan boiler from the Moscow-Kazan Ry. indicated such a high percentage in economy that it was checked by further test runs before being accepted as authentic.

It is felt that this boiler, which is now safely beyond the experimental stage, will be further developed with the painstaking care which is so prominent a characteristic in foreign railroad procedure. It would be interesting, indeed, and we believe well worth the trial if some railroad in this country would give it the same thorough try-out. The inference is not intended in this connection that the Brotan boiler would be adapted to our varying service requirements at large, but it is confidently believed that in many services it would work with far more economy and efficiency than many of the existing designs.

PLASTER OF PARIS PATTERNS FOR DIES TO MAKE PRESSED STEEL CAR SHAPES

The editorial mention last month* of the economy which would result in the instance of a railroad making its own pressed steel car shapes brings the following very interesting letter, which, on account of its novel and decidedly valuable suggestion embodied, is reproduced without abbreviation.

TO THE EDITOR:

In reference to your editorial in the November issue, in which you say that the high drawing room and pattern costs, in particular the latter, operate against the railroads getting out dies to make their own pressed steel shapes for car repair, I have a suggestion to offer, which if properly developed should abolish these two items of cost altogether.

While I do not know a great deal about the design, or even the appearance of car shapes, such as I have seen did not appear to be very elaborate. Some of them, in fact those which require the greatest number of renewals, so I have been told, are quite simple, in some instances being merely a flat piece of iron with a few right angle bends. You no doubt know what I mean in this connection better than I do myself, so I will not go further in trying to describe the shapes.

My idea, in brief, is to stand the shape itself, for which dies are required, upright in a box, or some contrivance of the kind, and then fill around it with plaster of Paris. It seems to me that when this sets, and it is carefully sawed into two parts at the proper place, you would have in reality two plaster of Paris reproductions of just what the top and bottom cast iron dies would have to be to make that shape in the flange press. Having secured the plaster of Paris moulds, my thought is that they might be considered as patterns. In other words, send them to the foundry and let them ram them up and pour, just the same as they handle the regular wood patterns, only with a little more care.

I have never tried this, of course, because I never had the chance, but I have been thinking it over for some time in connection with applying it to some bridge work parts. When I saw your editorial referred to, it struck me that it might be equally applied to car shapes. At all events, it may help to solve the cost problem which you said interferes with the railroads providing themselves with dies for car work, even though they may have a flange press which is practically standing idle.

C. S. HIGHAM.

Although the above is, of course, undeveloped, we think well of the idea from its practical aspect. There is no reason why a steel shape cannot be set up edgewise in a rough wood box, either rectangular or square, and the plaster of Paris poured around it as suggested. A laborer at $1.25 per day could knock the box together in a few minutes, fill the mould and part it. No drawings or prints become necessary, as the shape itself forms the guide, and the pattern shop cost, of which we have had something to say, is eliminated.

The idea appeals to us as being well worthy of a trial. Certainly the expense of the latter will be insignificant, and if the plaster of Paris patterns obtained are sufficiently strong to withstand the foundry operations, there is nothing to prevent the success of the scheme. Car shapes, as a rule, are rough, and their exact dimensions need not be absolutely insisted on in the instance of repair parts where there is generally considerable latitude allowable. Therefore the item of shrinkage when the dies are cast from these plaster of paris patterns, which, of course, would represent the finished size of the dies, need not seriously interfere with the results.

* See page 440, November issue.

LOCOMOTIVE TERMINALS

In the January, February and March issues of this year, there appears an extensive discussion of the many features and details, which, taken altogether, go to make up a satisfactory and efficient arrangement for properly taking care of locomotives at division points. As locomotives continue to increase in size the difficulty of properly caring for them is increasing at even a higher speed, until at present, there is probably no subject more worthy of attention and study among the large number which are constantly confronting motive power officials.

In this issue is devoted a large amount of space to a full description of a moderate sized terminal which has recently been constructed at Corning, N. Y. This terminal is the result of a long and careful investigation of the subject and in many particulars forms practically a model for division points handling between 75 and 100 locomotives in twenty-four hours. While, of course, it is possible to criticize some of the details of this arrangement the essential features are practically perfect. All of the most important appliances that have proven themselves to be thoroughly satisfactory have been applied and particular attention has been given to furnishing comfortable surroundings and ample facilities so that high grade workmen will be able to give high grade results.

POPPET VALVES FOR LOCOMOTIVES

The possible use of poppet valves to effect the steam distribution in locomotive cylinders has never been viewed with favor in this country, but the success which has attended the innovation abroad must necessarily impel some serious consideration of the subject. In several quarters of Europe it has been unqualifiedly endorsed by the highest authorities (and this is especially true in the instance of the Prussian State Railways, where it is embodied in the very latest types of locomotives.) Particularly this motion is said to be applicable to high speeds, working safely and exactly at revolutions ranging from 250 to 300 per minute. The type employed is that of Lentz, and it was prominently featured in some powerful express engines at the Brussels Exhibition.

In this clever and decidedly interesting treatment of a somewhat difficult proposition, the four double-seated poppet valves, controlling the outlets and inlets, are arranged to operate vertically in a cast iron valve case which is bolted steam tight to the cylinder proper. The actuating mechanism of the valves consists of a simple cam rod, corresponding to and about in the same location as the valve stem in American practice, the movement of which, derived from the outside link valve gear, raises and lowers the valves on their respective seats at the proper interval.

The conclusions which inspired this gear were based largely on the knowledge of the increasing use of high pressure, and particularly of high degrees of superheat which revealed deficiencies in the ordinary D and piston valve gear. It was also appreciated that with the ordinary valves a complex guide motion was necessitated which was scarcely suited for high speeds. A further advantage claimed for this system is the positive closing of the valves even with high degrees of superheat, as well as favorable conditions of opening and accelerated closing. The valves also offer positive security against water hammer, through their practical operation as safety valves of large section.

When the laborious and painstaking efforts which characterize experimental work on European railways, with the certainty of achieving ultimate results before anything is permanently adopted, is borne in mind, it is quite evident that the Prussian State Railways, and others interested, are not blundering blindly into radical transformation of previous devices. The very fact of the Lentz valve application to the fastest express engines on those railways affords food for thought, and certainly for speculation on the outcome. Whatever the developments may be, they will be awaited with unusual interest, as the correct interpretation of the valve gear problem is not the least important question with which railroads at large have to deal.

AN ILL-ADVISED STANDARDIZATION

From all accounts the standardization of locomotives in India, which has been under way in somewhat desultory fashion since 1903, is proving to be largely barren in results, the reports therefrom indicating that after seven years' trial that country is no nearer to having standards than it was at the incipiency of the idea. The efforts made toward that end have been watched with much interest both at home and abroad, and especially in England, where the plan was from the first sensibly viewed with distrust. Now that the results expected have not materialized it is not surprising that the present attitude of the English technical press is to belittle the proposition in general, and to hold up its non-success as an object lesson to other countries who may incline toward similar procedure.

It is extremely improbable, however, that any such thing will be again attempted anywhere. It should never have been essayed in the first place, and never would have been in this country, but still the lessons taught may be of value. This Indian endeavor was not intended to be the mere standardization of power by an individual line within itself, but was broadly aimed to include locomotives of all lines. Properly viewed it appears as a preposterous scheme; one from which, even if successful, little benefit could accrue. Primarily, however, criticism may be best directed toward the manifest short-sighted policy of attempting the production of an universal standard engine to serve indefinitely the continually varying requirements of rapidly expanding railroads. Although it is true that in maturing this ill-advised scheme some six or eight so-called standard types have been laboriously evolved, they were out of date practically on completion, or, as even more forcibly put by one of the Indian motive power men, "The ink was hardly dry on a set of drawings before it was found that something more powerful was needed."

To predetermine general engine types for the future is absurd or paradoxical, because the inference may be readily drawn that so long as they cannot be adapted to a possible expansion in traffic, the traffic must be adapted to them. If heavier paying loads are offered, and they will increase year by year in that rapidly growing country, they cannot be accepted as single train weights, because the latter must necessarily be rigidly defined in accordance with the capacity of the standard freight locomotive. There is no economy in double-heading, or in running sections of trains when one section should suffice. Standardization in this broad application becomes a bar to the progress and prosperity of all the railroads involved. It effectually checks the development of the locomotive, which can only follow where competition is present, or through a recurrence of original designs, and it may as well be added that quite a field for development yet remains in the present design of the Indian locomotive. It would, indeed, be unfortunate should this be retarded through a vague and elusive chase for types which at the best can only live their day.

The fact is interesting, although there is nothing mystifying about it, that the new standard types are doing no better than the engines which they superseded. India is a country affording every possible variation in physical characteristics. In one section it is mountainous, with heavy gradient roads and high degree curves, and in another practically level, with tangents of unusual length. The former locomotives were designed to meet strictly local conditions, while now the standard freight engine, for instance, is entirely unsuitable in its role as a general machine for all conditions. This, of course, needs no argument to substantiate, and yet this standard locomotive was designed as a composite type to be used anywhere in India. If adequate for grade work it would not make time on a level road, or if equal to low grade requirements, its high wheel was not adapted to hill climbing, and so on.

It is recalled that some years ago in the United States the same scheme was discussed with some attempt at gravity, although the discussion was entirely informal, and the matter never came before a body whose influence might be strong enough to put it under way. In brief, as we recall it, the proposition was for all motive power officials to get together, as they have subsequently done to their regret in India, with the end in view to limit the design of power in general to less than six standard types.

For all around work, in fast freight and passenger service, the ten-wheel, or 4-6-0, was suggested; the 2-6-0 for ordinary freight; the 4-4-0 for local passenger, and the 0-6-0 for switching purposes. This matter was talked over thoroughly, but there was no attempt at concerted action. It was contended that the cost of locomotives would be greatly reduced when generally standardized, and in fact about the same arguments were advanced as in the instance of the Indian conclave. Fortunately, the wild scheme never became foisted on this country.

Much useful work has been done in India during the past seven years in standardizing specifications, certain features of equipment, etc., and therefore the labors of the committee have not by any means been altogether to no avail. The only feature to be regretted was that it did not stop when the standard locomotive question was reached, and devote its energies to securing uniformity in details, and in maintenance methods, but not in types, which can never be brought about in India or any other country.

THE ANNUAL INDEX

The annual index which it has been our custom to issue with the December number, will this year accompany the January issue. We will be able, however, to furnish copies of it to those who wish to have their volumes bound up immediately, by December 15.

Railway Business Association Dinner

An air of cheerfulness and optimisim was everywhere to be seen at the closing of the second annual dinner of the Railway Business Association where 800 members and guests had listened attentively to the speeches of Martin A. Knapp, chairman of the Interstate Commerce Commission; Daniel Willard, president of the B. & O. R. R. and of the American Railway Association and John Claflin, president of the H. B. Claflin Co. The statements and remarks of these spokesmen for the three principles in the present rate controversy—the government, the railroads and the shippers—gave good reason for cheerfulness to the members of an association dedicated to fair play. It was clearly evident that the spirit of fairness and justice to the railroads as well as to their patrons for which the Railway Business Association has been working since its organization is becoming, largely through its efforts, more generally recognized as not only right but also the best business policy.

To Geo. A. Post as organizer and president of this unique Association is due a large part of the credit for its most gratifying success, and it was Mr. Post who for the second time occupied the chair of toastmaster at the dinner held on the evening of November 22, at the Waldorf-Astoria, New York. At the speakers table in addition to Messrs. Willard, Knapp and Claflin were many other well known men, among them being the following:

E. A. S. Clark, Lackawanna Steel Company; James J. Hooker, president, Receivers and Shippers' Association; George W. Simmons, vice-president, Simmons Hardware Co.; John Kirby, Jr., president, National Association of Manufacturers; C. M. Schwab, president, Bethlehem Steel Company; Isidor Strauss, of R. H. Macy & Company; Ralph Pulitzer, publisher, *New York World;* A. B. Hepburn, president, New York Chamber of Commerce; George W. Perkins, of J. P. Morgan & Company; John Wanamaker; John C. Spooner, former United States Senator; Frank A. Munsey, publisher; W. E. Cory, president, United States Steel Corporation; W. P. Hamilton, editor, *Wall Street Journal;* Otto H. Kuhn, of Kuhn, Loeb & Company; Warren S. Stone, grand chief, Brotherhood of Locomotive Engineers; and P. H. Morrissey, president, American Railway Employees Association. The Public Service Commission of New York was also represented at the speakers' table by several members.

A number of songs, written for the occasion by Paul West, proved a most entertaining feature.

Abstracts of the three principle speeches follow:

Abstract of Mr. Knapp's Address.

The question of railway rates, that is to say, of railway revenues, involves vastly more than the direct interests of shippers or shareholders. In a very real sense, in a sense which is fortunately coming to be better understood, it is a great question of national policy second to none in its economic importance. That the compulsion of competition among the carriers is an unwise and mistaken policy I am persuaded. It is out of the question to have the presence of competition and the absence of discrimination. Just so long as competition between carriers is unrestrained, just so long will it result in policies which are dangerous, for to compete is to discriminate. It is a fallacy to condemn discrimination and at the same time to insist upon the very policy which promotes it. For this reason I advocate the legal sanction of coöperative action between railways regarding rates.

Speaking only for myself, and without reference to the pending controversy over rate advances or any other concrete instance, I suggest three aspects of this question which are of immediate and intense public concern. If our country is to grow and prosper as it ought, if its untold resources are to be developed as they ought, and its swelling numbers find profitable employment as they ought, we need and must have railway earnings sufficient for three things:

First, a return on railway investments of such amount and so well assured as to attract and secure the necessary capital—an enormous sum in the aggregate—to improve existing roads and to construct without delay thousands of miles of new lines in fruitful districts now destitute of any means of transportation. It is a matter of common knowledge that the output of traffic for the fiscal year 1907 exceeded our entire carrying capacity on land and water. With the rapid increase of population and of productive efficiency, that is, with a greater army of workers and better industrial organization, the volume of that year ought to be and will be nearly doubled in another decade if only we can provide for its prompt and proper distribution. And when we think of the rich regions yet unopened because unserved, when we recall, for example, that there is today in the old state of Maine a section larger than the whole of Massachusetts in which there is not a rod of railway, must we not be impressed with a realization of pressing need and of boundless opportunity. Since it our national policy—and long will be, I trust—to rely upon private capital and private enterprise to provide these great highways of commerce, to improve and multiply them in pace with our requirements, must we not in the larger public interests, whatever may be thought by this or that shipper, make the business of furnishing railway transportation, which shall be up to the best standard of efficiency, convenience and safety, so desirable to the investor that the necessary funds for betterments and extensions will be forthcoming, and so attractive as a vocation that the highest ability will be employed in its management? Otherwise, if unhappily this is not done, must not our country come measurably to a standstill and face a future of comparative stagnation?

Second, the payment of liberal wages to an adequate number of competent men. This not only to insure increasing skill and reliability in a service which is all the while becoming more exacting, and on which the safety and comfort of the public constantly depend, but also because of the very great influence of railway wages upon the compensation of labor in every sphere and grade of private employment. To my mind the fundamental social problem is to provide, by the wise development of our institutions and without radical action or injustice, for a more equable diffusion of the bountiful wealth which the earth produces. Now, as a large and increasing majority of the able bodied live, and must live, by working for others in some capacity, a high and advancing standard of payment for service of every sort tends strongly to promote, and is the best practical means to bring about, the degree of equality in social welfare which makes for the satisfaction and happiness of all our people.

Third, the betterment of existing lines so as to greatly augment their serviceableness to the public, as can in varying degree be done everywhere, without unnecessary and undesirable increase in capitalization. Every dollar borrowed to improve a road now in operation involves a permanent addition to the interest charge which the public is required to pay; the improvement from current earnings puts no lien upon the property but rather augments its value and usefulness, and by adding to the security of the capital already invested tends to a lower rate of interest upon that capital. Broadly speaking, this means a national policy, so to speak, in respect of railway rates and revenues in harmony with our national policy in other matters of public concern, and in accordance with that enlarging spirit of altruism which manifests itself in public as well as in private life, and which impels the present assumption of burdens that might be escaped or deferred in order that another generation may have an easier task and a larger opportunity. Is it not in this particular field a wise and patriotic policy?

Abstract of Mr. Willard's Address.

The industries represented by your association constitute a powerful economic force, and your organization has for the first time brought that force to bear on public opinion. It was fortunate for the railways of this country, and I believe a fortunate thing for its commercial industries as well, when the Railway Business Association was formed. You have already performed a most valuable service in the way of bringing about a better understanding between the railway managers and the railway users, and your efforts in that direction deserve hearty recognition. I do not hesitate to say that the railways fully appreciate and gladly acknowledge what you have actually accomplished and will welcome a continuation of the same policy.

I am extremely anxious to see a better understanding reached between the railways and those who use them; but, I have never seen any substantial or lasting progress made towards such understanding by parties holding views greatly at variance, until they were both ready and willing to accept the truth, if it could be found and act accordingly.

The American railway, except in the extreme East, has almost universally gone ahead of the population or even the settler. The building of a railway under such circumstances was a hazardous undertaking Men could not be found willing to assume the altogether too apparent risk of loss, unless in some manner there was thought to be something which promised large reward. In many instances large reward was realized. Had it not been so there would have been no railways. Similar risks were assumed in other enterprises in a new country and similar expectations of large reward were indulged in and just as frequently realized.

In the course of time complaints began to be made that the railways were showing special favors to some individuals and communities and withholding such favors from others. It was claimed that rebates were being granted the better to cover up the transaction. It was claimed also that the roads charged less in some instances for a long haul than for a shorter haul when the circumstances were substantially the same. It was claimed that the railroads exercised a controlling influence over some of the legislative bodies, such influence resting largely upon the issuance of free transportation and in some cases the actual payment of money. It was claimed that the railways were over-capitalized and that in some instances large fortunes were made by improper, not to say illegal, practices in that connection. Doubtless there was sufficient cause for complaint. To hold otherwise would be to hold that men engaged in railway affairs were not subject to the same human limitations and weaknesses that are known to be the common heritage of mankind. It was claimed that the pooling practice, at that time much in evidence, was inimical to the interest of the shipper and its abolishment was demanded, though so far as I am able to learn, no general complaint was ever made that rates, as a whole, were excessively high. Other minor complaints against the carriers were also registered.

The feeling aroused by these various practices finally found expression in laws, notably the Interstate Commerce act, with successive acts amendatory thereof.

Granting, for the sake of argument, that the builders, owners and managers of the railways were in common with the rest of mankind subject to all weaknesses and limitations that the human race is heir to, let us see how much foundation in fact there is, or ought to be, at the present time for such distrust as still seems to exist.

The rebate and unjust discrimination have disappeared, or, if not altogether, then the relief is to be found in the enforcement of the existing law. I submit no additional law is necessary in that direction. The long and short haul question seems to be fully covered by the recent ammendment Recognizing, however, the far reaching effect the so-called long haul practice has had upon the general commercial and industrial development of this country, Congress has seen fit—wisely, I think—to give the commission much latitude concerning it. A strict and literal enforcement of the law would mean commercial disaster to many communities.

The influence of the railways upon legislation has been, I eblieve, largely if not entirely eliminated. This has come about partly by the people requiring of their representatives a closer accountability and partly by the fact that the railways, recognizing the higher ethical standard concerning such matters to-day, have endeavored to adjust their practices in harmony therewith.

The claim that the American railways are over-capitalized is still urged in some quarters. In that connection the following comparisons of capitalizations per mile are interesting:

England	$275,040
Belgium	169,806
France	139,390
Austria	112,879
Germany	109,788
United States	59,000

In my opinion to duplicate the American railway system to-day would cost a sum very much in excess of the existing capitalization, and while I do not believe a physical valuation of the railways would serve any useful purpose, I am convinced that the railways have nothing to fear in that direction.

James J. Hill, whose knowledge of this subject rests upon the most careful thought and inquiry, has well said: "The American railway pays the highest wages in the world out of the lowest rates in the world, after having set down to capital account the lowest capitalization per mile of all the great countries of the world."

While the railways as they stand to-day, have cost nearly $14,000,000,000, as shown by their outstanding capitalization, it is certain that the development of the country will make necessary further large expenditures for additions to and betterments of the existing lines. It has been well stated that one billion dollars a year, for a number of years at least, will be absolutely necessary for these purposes. How will the money be obtained? By offering something in the way of a security sufficiently attractive to make the money forthcoming; for, as one of the honorable members of the Interstate Commerce Commission has well said:

"We can provide by legislation the sort of cars which a railway shall use and the rates which it shall impose; we can not by legislation force one single dollar of private capital into railway investment against its will."

Much has been said about what is a fair and reasonable return on money invested in railway securities. If the railways were finished and no new capital needed, it might then be interesting to discuss what rate of interest or dividend should be paid in the future on money borrowed in the past. That, however, is not the situation; the railroads are not finished and they will need and must have large sums in the future and it will not be obtained by telling the man whose money is desired that he will be paid a *fair* rate. The man who has money to lend, taking him as a class, will decide, not what is a fair rate, but what is a *satisfactory rate to him,* and in reaching that conclusion he will be influenced by many elements, not necessary now to refer to, but which taken as a whole constitute credit.

The question of what is a fair and reasonable freight rate is also a difficult one to determine. Certain it is, as I view it, that the sum of all such rates must at least be sufficient, when combined with efficient management, to furnish such net earnings as will enable the individual road to obtain the necessary new capital when needed on a favorable basis, otherwise, because of impaired credit, money could not be raised at all, or if raised, then under such conditions as would probably add to the embarrassment.

I assume we are all equally interested in the prosperity of our country as a whole. We can not have such prosperity as we all desire while the second largest industry in the land, measured by capital investment, remains inert. I positively know that there is to-day in the minds of railway managers a feeling of hesitancy, of uncertainty, as regards the future. Possibly that feeling is not justified by the facts, by the conditions. Possibly the managers are mistaken. None the less, the feeling is there and it is dominating the situation, and the all important question is—how can it be corrected? How can the feeling of distrust, which now rightly or wrongly so powerfully influences the policy of the railways, be allayed? I should say by removing the cause, and, unless I have altogether failed to make clear what is in my mind, I think the cause, as I view it, should be apparent; but to be specific, let the people who use the roads and want the roads, now indicate that, having secured the passage of such laws as they considered necessary in order to correct the conditions complained of in the past, they are now willing (as I think they should be) to open a new account with the future. Let them consider each new proposal for legislation with entire freedom from any spirit of retaliation. I do not say that it is encessary to undo anything already done (although experience may show such action to be wise in some instances), but I do say that the railways should be given a respite from further legislation—State or Federal—for a time at least, and until they can work out some of the many problems now confronting them. If such a course should find favor in the minds of the people and reflected in their attitude toward the carriers, I do not hesitate to say that the patient now indisposed would immediately show signs of convalescence.

The remedy suggested is not a serious one. Is not the experiment worth trying?

Abstract of Mr. Claflin's Address.

How to meet the increased cost of living is a problem of the time. We may partially explain the advanced prices of what we eat by the reduced proportion of food producers to food consumers, and we may to an extent explain the increased cost of other things which we use by the high wages and the decreased efficiency of labor, but these explanations only show us that we may not soon expect any considerable reduction in the cost of living; that as investors and as business men we must face increased expenses, and it behooves us to determine what we can do, if anything, to increase the income of the community in general and of ourselves in particular.

The railways up to a certain point have indicated the way in which increased expenditures can be met. They have been able to increase their business largely, and a similar increase of business is the solution of his particular difficulties that every merchant would welcome. The railways now have reached a point where it seems difficult for them to continue to increase their gross revenue materially without very great expenditures for betterments and for extensions. Under ordinary conditions the money to pay for such extensions and betterments could readily be had by the sale of bonds bearing a moderate rate of interest. At the present time, however, investors are asking larger returns on their capital than in the near past, and foreign investors, especially those who seek only the choicest of American securities, are inclined to be indifferent to the offerings of America railways, because they are doubtful in view of the recent advance in wages by the railways, whether or not the railways now have a safe margin of profit which will enable them to pay interest on all their fixed obligations and to continue reasonable disbursements to their shareholders. It seems to me the solution of this doubt is of the utmost importance to the general prosperity of this country, and its solution may be facilitated or delayed by the attitude of the merchants of the United States in regard to the advances in freight rates which the railways have proposed.

As a wholesale merchant in New York the question to me is partly academic because as a wholesaler I pay but a small portion of the freight which is charged on merchandise shipped from New York, but as an investor in retail stores throughout the country, the question lies within the scope of my personal investigation and may affect my income largely. I ask then, will it be advantageous for the average merchant outside of New York to pay some increase in freight rates to help the general situation? I think it will.

This solution of the problem for the merchant as well as for the railways seems to me the logical way out. Mercantile expenses cannot be reduced materially without reducing business proportionately, but under the impetus of a general growth of the country, mercantile business may increase in the future as it has increased in the past with sufficient rapidity to keep expenses within reasonable ratio to the amount of sales.

How can the general growth and general prosperity be best promoted? I think the railway will answer this question satisfactorily if by friendly co-operation we give them the power to go ahead.

At the annual business meeting of the Association the following officers were re-elected: President, George A. Post; vice-presidents, H. H. Westinghouse, O. H. Cutler, W. H. Marshall, E. S. S. Keith, A. H. Mulliken, O. P. Letchworth, A. M. Kittredge; treasurer, Charles A. Moore.

The Lentz Poppet Valve Gear

FOR HIGH SPEED WORK AND GENERAL EFFICIENCY THIS NOVEL VALVE GEAR IS VIEWED WITH FAVOR BY MANY FOREIGN ROADS

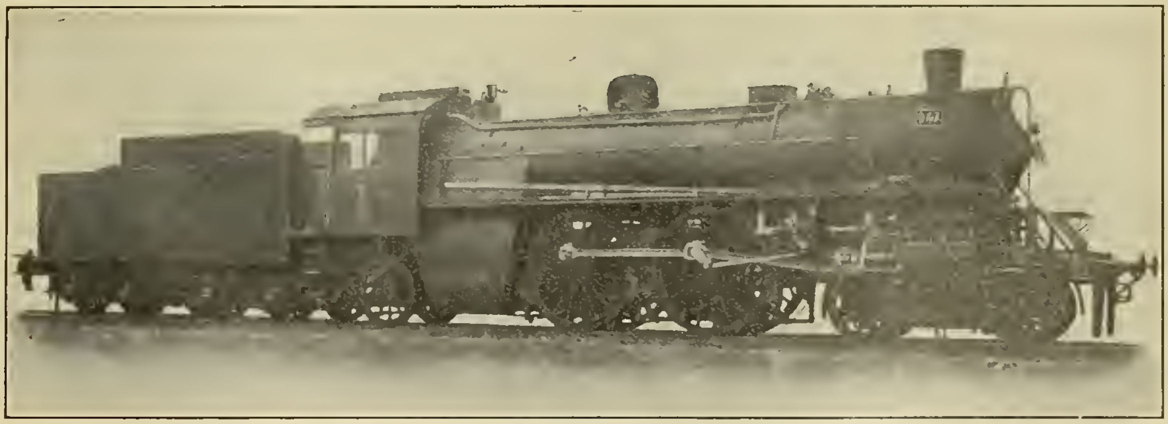
The possible use of poppet valves to effect the steam distribution in locomotive cylinders has never been attempted in this country, but the success which has attended the innovation abroad must necessarily impel some serious consideration of the subject. In several quarters of Europe it has been unqualifiedly endorsed by the highest authorities, and this is especially true in the instance of the Prussian State Railways, where it is embodied in the very latest types of locomotives. Particularly this motion is said to be applicable to high speeds, working safely and exactly at revolutions ranging from 250 to 300 per minute. The type employed is that of Lentz, and it was prominently featured in some powerful express engines at the Brussels Exhibition.

The Hannoversche Maschinenbau A. G. of Germany was the first to apply this gear to a locomotive engine in 1905, when a 2-4-0 tank engine was being rebuilt. On the same occasion a Pielock superheater was installed, and the engine achieved in service a saving in coal of 19.5 per cent. and a saving in water of 30.56 per cent., as compared with similar tank locomotives fitted with slide valves, and working with saturated steam. These figures were accurately determined during a series of trial runs. As no fault was found with the Lentz poppet valve gear of this locomotive, which is still used in heavy regular train service, two others in 1906 were similarly equipped. These, a four cylinder balanced compound, and a six wheel coupled tank locomotive of standard gauge, were exhibited at the Milan International Exposition of 1906.

Although the departure from existing types of cylinder valves was rather startling, the new design grew rapidly in favor, and it may now be said to possess a favorable reputation. Up to May, 1910, stationary engines, locomotives, traction engines and marine engines, with a total of 1,114,000 indicated horsepower have been fitted with this gear. Fifty-seven high-powered express locomotives are now in course of construction, for which the Lentz gear has been specified.

In this clever and decidedly interesting treatment of a somewhat difficult proposition, the four double-seated poppet valves, controlling the outlets and inlets, are arranged to operate vertically in a cast iron valve case which is bolted steam tight to the cylinder proper. The actuating mechanism of the valves consists of a simple cam rod, corresponding to and about in the same location as the valve stem in American practice, the movement of which, derived from the outside link valve gear, raises and lowers the valves on their respective seats at the proper interval.

The four valves (two inlet valves towards the middle and two outlet valves toward the ends) are placed in a row, one behind the other. They are constructed as double seat valves. Their spindles are fitted with so-called labyrinth packing only, which, as experience in steam engines goes to show, can be made to work perfectly steam tight and at the same time practically without friction, when accurately constructed. The valves weigh but 7.3 pounds each and are weighted by springs.

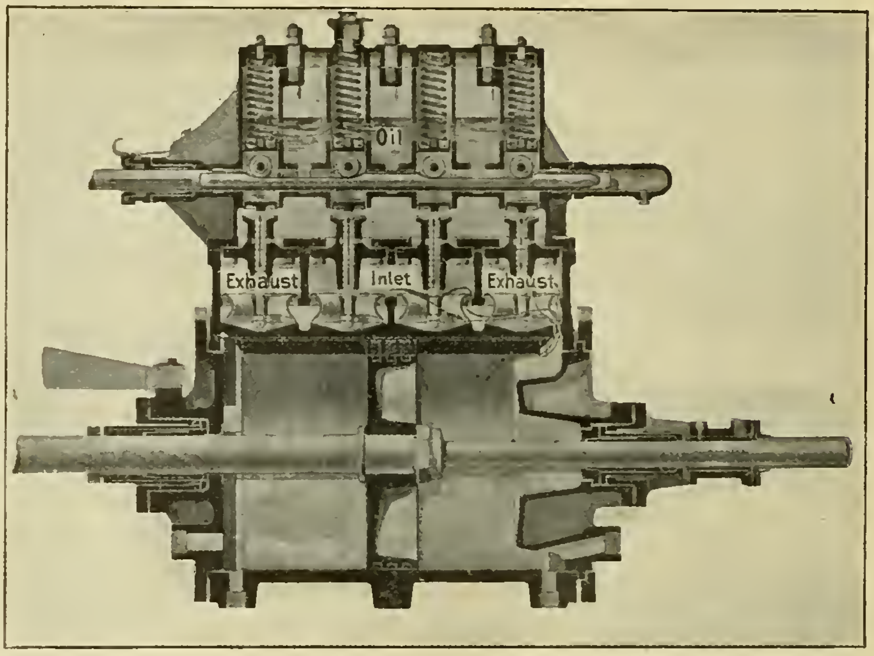


LOCOMOTIVE ON THE PRUSSIAN STATE RAILWAY EQUIPPED WITH LENTZ POPPET VALVES

This brief explanation roughly describes the general arrangement, but the design embodies many important details which compel admiration through the ingenuity displayed in their application. For instance, the cast iron valve case previously mentioned is in two sections, the upper section containing the spiral springs encircling the valve spindles to insure their positive closing at the highest number of revolutions, while the lower part of the case becomes an exhaust chamber, fitted with small pipes to drain off whatever steam and condensation which may escape through the spindles. These latter, screwed into their respective valves, move steam tight in cast iron guides, thus isolating the upper from the lower part of the valve case.

The detail construction of the valve spindles is very interesting. They carry, above what may be called the dividing line of the valve case, broad cylinder heads, in which very hard ground rollers are arranged. It is against these rollers that the cam rod acts, by means of cams of special form, on which the rollers turning freely in the spindle head, have their movement.

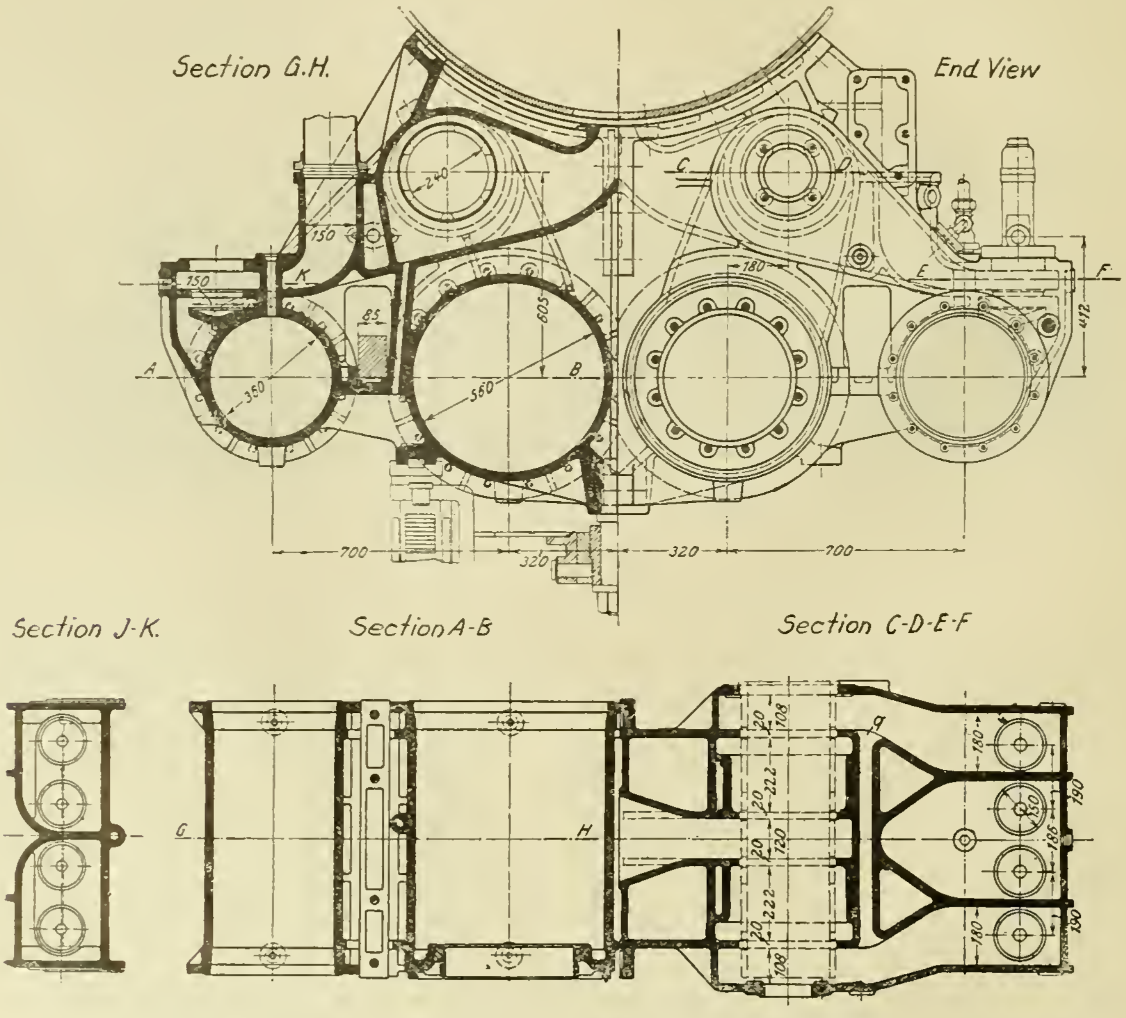
Referring again to the upper part of the valve case, this being steam tight in relation to the lower part, opportunity has been taken to convert it into an oil bath, so that the rollers, spindle heads, and the cam rod work in a continuous lubricant. This portion of the valve case is supplied with oil through an ordinary cap nut, or through one of the heads provided to remove the valve spindle spiral springs should this prove necessary. It may be mentioned in this connection that the natural objection which might be raised to the necessity for applying springs to rapidly working poppet valves need not be considered serious in this construction, as the valves are almost perfectly balanced, and comparatively weak springs have been found to be adequate.



GENERAL ARRANGEMENT OF THE LENTZ POPPET VALVES

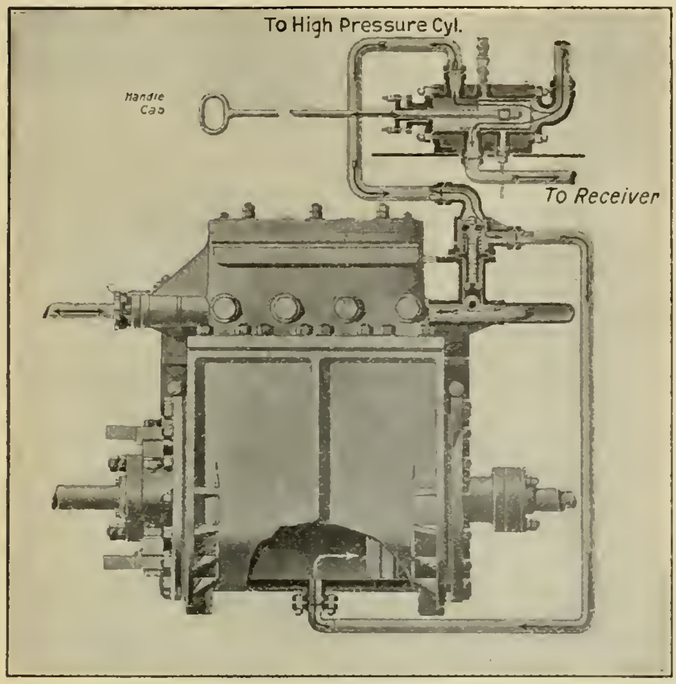
The conclusions which inspired this gear were based largely on the knowledge of the increasing use of high pressure, and particularly of high degrees of superheat which revealed deficiencies in the ordinary D and piston valve gear. It was also appreciated that with the ordinary valves a complex guide motion was necessitated which was scarcely suited for high speeds. A further advantage claimed for this system is the positive closing of the valves even with high degrees of superheat, as well as favorable conditions of opening and accelerated closing. The valves also offer positive security against water hammer, through their practical operation as safety valves of large section.

In conjunction with this form of poppet valves Ranafier's starting gear is very frequently employed and is viewed with



CYLINDER DESIGNED TO USE LENTZ POPPET VALVES (THE DIMENSIONS ARE IN CENTIMETERS. 1 CM. = .3937 INCH) equal favor. It forms one of the features of the four cylinder compound locomotive herein illustrated, and which was awarded the grand prize at the Brussels Exposition. The claim made for the Ranafier apparatus is that an extremely high tractive effort is developed and that all degrees of cut off can be employed, no matter at what speed the engine is running when the locomotive is working compound.

The gear consists in the main of a valve placed above a front extension of the slide valve rod which is in operation when the



RANAFIERS STARTING GEAR USED ON COMPOUND LOCOMOTIVES

engine is running in the ordinary manner, being held against its seat by the spring. If it is desired to increase the tractive effort, live steam can be fed from the boiler to the starting valve by means of a special steam distributing piston, which can be worked from the foot plate by a pull handle. This produces a pressure above that of the atmosphere, which tends to open the valve and causes the roller fixed to the latter to be pressed against the valve rod. As soon as the roller sinks into a special notch on the rod, the starting valve is opened, thus opening the passage for live steam to the middle of the high pressure cylinder. If, however, the piston is not in the proper position in the cylinder, the valve rod closes the auxiliary valve until it passes the center, thus providing by the position of the notch that a counter pressure cannot be produced through the live steam pipe, no matter what the position of the cranks may be, and no matter whether the engine is running forward or backward. Should, however, the position of the cranks be unfavorable, so that the auxiliary steam supply to the high pressure cylinder is cut off, the steam distributing piston must be moved further forward. This operation opens a pipe connection which conducts live steam to the receiver, so that the low pressure cylinder, the main distributing gear of which allows a degree of admission up to 90 per cent., can also be supplied with steam at high pressure. The device is arranged so that the steam distributing piston is made to close by steam pressure. As soon as the starting effort has produced its effect, after one or a few revolutions, the device closes automatically when the handle in the cab is released. The starting valve is now brought back by the pressure of the spring to the position of rest, which allows of the free movement of the reversing rod under the roller.

When the laborious and painstaking efforts which characterize experimental work on European railways, with the certainty of achieving ultimate results before anything is permanently adopted, is borne in mind, it is quite evident that the Prussian State Railways, and others interested, are not blundering blindly into radical transformation of previous devices. The very fact of the Lentz valve application to the fastest express engines on those railways affords food for thought, and certainly for speculation on the outcome. Whatever the developments may be, they will be awaited with unusual interest, as the correct interpretation of the valve gear problem is not the least important question with which railroads at large have to deal.

Pennsylvania Railroad To Use McAdoo Tunnel.—Negotiations have been completed between the Pennsylvania Railroad Company and William G. McAdoo's Hudson-Manhattan Railroad Company, whereby after July 1 the Pennsylvania local traffic, instead of coming to the new Pennsylvania station at Thirty-third street and Seventh avenue, will be diverted from Newark to the McAdoo tunnels, leaving the large terminal free for the handling of through trains from the west, Washington, Baltimore and Philadelphia and the Long Island traffic. This interesting information was given by William G. McAdoo, president of the Hudson-Manhattan Company, in an interview, in which he discussed the plans of his company for further extensions and improvements of its tunnel and subway systems.

Crewe Works to Turn Out Its 5000th Locomotive.—C. J. Bowen Cooke, the chief mechanical engineer of the London and North-Western Railway, has announced that next year, the Coronation year, will witness the completion of the 5000th locomotive at the Crewe Works. It was in 1866 that the 1000th engine was turned out, Mr. Ramsbottom being the chief engineer, and the 4000th was completed in March, 1900, under Mr. Webb. It is now 67 years ago that the first locomotive was built at Crewe. The 5000th engine will probably be one of a new type of passenger tank engine. In all 20 of this class are to be constructed of the 2-6-4 type. The cylinders will be 18½ in. in diameter and the coupled wheels 5 ft. 6 in.

Telephone Dispatching on the Boston and Maine R. R.—The Boston and Maine R. R. is gradually substituting the telephone for the telegraph in train dispatching. It now uses the telephone on three circuits: From Boston to Fitchburg, a distance of 51 miles, involving 102 miles of wire and 19 stations, which was installed August 22, 1909; from Concord to White River Junction on the Concord division, a distance of 87 miles, involving 174 miles of wire, with 28 stations, which was installed in April, 1910, and on the White Mountain division, 94 miles long, with 188 miles of wire, which was installed October 10, 1910.

Baltimore and Ohio Eliminating Tunnels.—Indicative of the improvements being made by the Baltimore and Ohio is the work of tunnel elimination that is being prosecuted throughout the system, open cuts being substituted wherever practicable. Particularly is this the case on the Cumberland division, whereon, between the towns of Cumberland and Grafton, four of the six existing tunnels are being made open-cut, and the big Kingwood bore is being rebuilt and equipped with a modern ventilating system that will conduce materially to the comfort of travelers and trainmen alike.

New Haven to Pension Old Employees.—At the annual meeting of the stockholders of the New Haven Railroad, held in New Haven on the afternoon of October 26th, the directors were empowered to pension employees for long and efficient service. The matter was presented to the board by President Mellen and the action taken because a doubt had been expressed by legal representatives as to whether or not the directors could legally vote such pensions. Mr. Mellen offered resolutions empowering the directors to pay such pensions after long and faithful service and on certain occasions, where the directors might consider it proper, to the families of the men who were deceased. The resolution was seconded by J. P. Morgan.

POWERFUL RADIAL DRILL FOR HIGH SPEED WORK

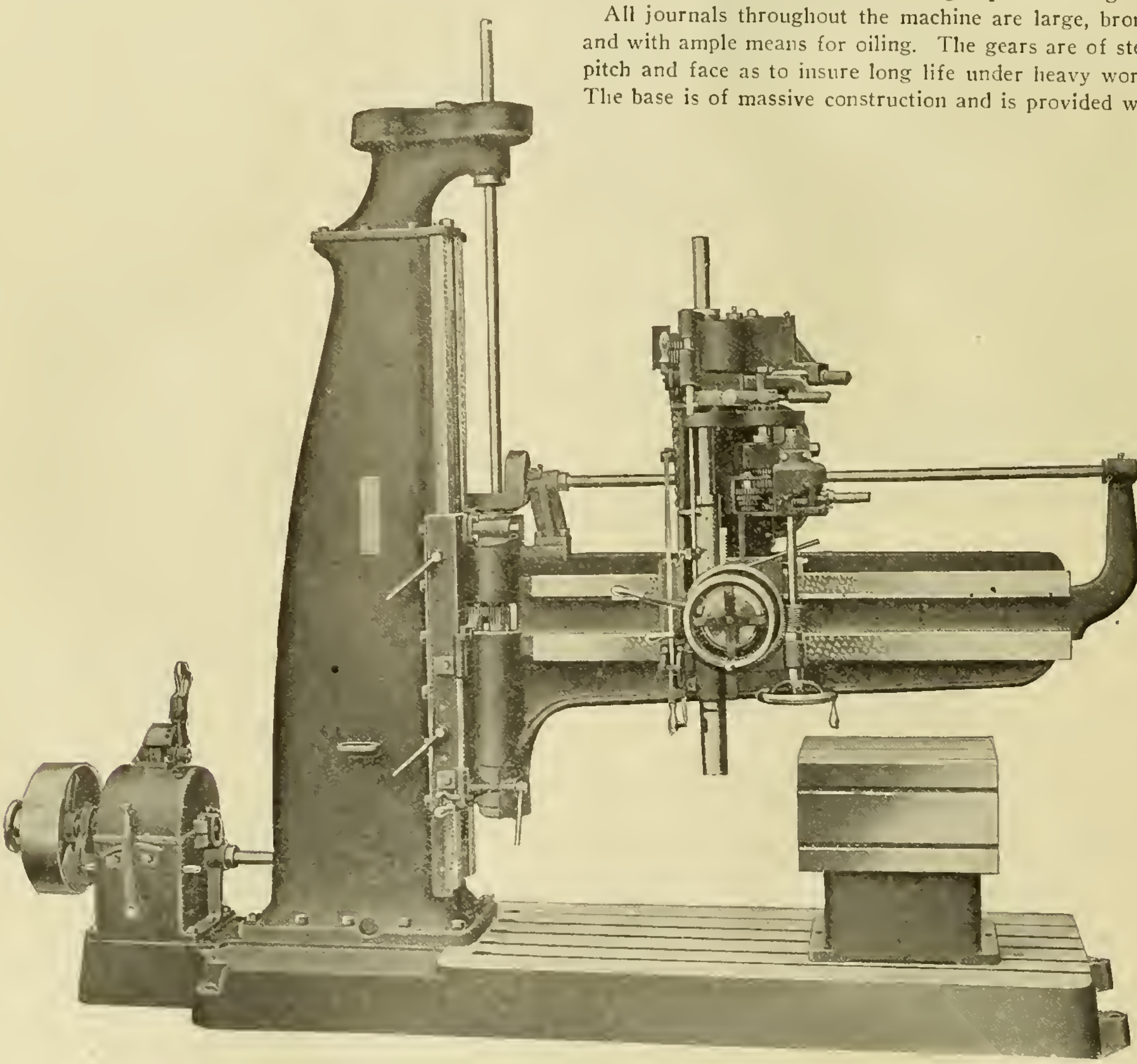
The specific field for drilling machines has formerly been the drilling and boring of holes of comparatively small diameters, but the steady development of this tool has resulted in the reaming and tapping of holes being added to the work of the drill, and by means of special tools and fixtures much work formerly done on the lathe is now being performed on the drill press. As a manufacturing tool the latter is steadily growing in favor, due to its simplicity, the readiness with which it can be gauged, and its comparatively low cost.

The machine herein illustrated represents the new radial drill, built by the Fosdick Machine Tool Co. of Cincinnati, O., which has been designed in 4, 5 and 6 ft. sizes for use of high speed steels, and which embody every feature to be found on an up-to-date drill. The machine is the standard of the makers, and is of the box column type which has proved its superiority in strength of other designs.

It will be noted that the arm is of the massive pipe section construction, the weight of which is carried on a heavy ball bearing, thus insuring easy rotation in the trunnions. The head is of simple construction, and has a long bearing on the arm. The back gears are located in the head, which permits of short and heavy shafts, very essential for modern high speed drilling. They furnish three changes of speed, and can be engaged or disengaged while the machine is in motion. The reverse functions are also operated from the front of the head, and are of the well-known toggle joint type, and will transmit the full power put in the machine at the lowest speeds. At the back of the head is the tapping attachment, fitted with large clutches which are provided with adjusting screws to take up the wear.

When the machine is fitted with the speed box eighteen spindle speeds, ranging from 16 to 360 revolutions per minute, are obtainable, and when fitted with cone pulleys there are twelve speeds. The spindle is made of crucible steel, accurately ground, and is fitted with a No. 5 Morse taper. The feed box is of the maker's well-known tumbler gear design, and permits eight changes of feed, ranging from .007 to .064 in. per revolution of the spindle. As the efficiency of a tool of this class depends very largely upon the convenience of manipulation, special attention to the location and arrangement of the operating levers is given. All feeds are instantly available while the machine is working by means of one lever. The quick return has also been redesigned to meet the modern demands of high speed drilling.

All journals throughout the machine are large, bronze bushed, and with ample means for oiling. The gears are of steel, of such pitch and face as to insure long life under heavy working loads, The base is of massive construction and is provided with large T slots, as is also the box table. These machines can be arranged for variable speed motor drive or constant speed motor drive through cone pulley or speed box.



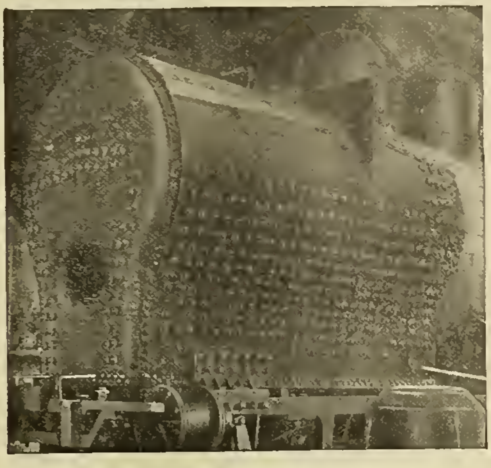
VERY POWERFUL RADIAL DRILL BUILT BY THE FOSDICK MACHINE TOOL CO.

THE MONORAIL CAR running between Bartow and City Island, New York, which met with an accident on the first day of its operation three months ago, has been rebuilt, and the road which has been carrying passengers experimentally for some weeks, hopes shortly to commence regular service under a new franchise.

RECORD COAL TONNAGE ON THE GREAT LAKES.—The highest coal tonnage record ever made in lake shipments will be broken this year. Officials of the coal companies in the Pittsburg district, which are heavy lake shippers, estimate that the 1909 movement for Northwest ports will be exceeded by 3,000,000 tons.

IMPROVED STAYBOLT CONDITIONS

During the last six years under the increasing use of the flexible staybolt, marked advancement has been made in the methods of staying to afford a less rigid construction in locomotive firebox assemblage. The practice in vogue in which the flexible staybolt is used in localities of greatest sheet expansion, point conclusively to the fact that not only is the breakage of staybolts reduced, compared to the use of the rigid staybolt, but in many instances it is practically eliminated, and side sheet cracking and rivet seam leaking is less frequent, demonstrating the advisability of providing suitable means to allow the heat-absorbing surfaces of the locomotive fireboxes to expand under less restraint than that afforded by the method of rigid staying. The expansion and contraction of the firebox sheets as well as the expansion of the outer shell of boiler, differ not so much in their relative course of extension when under temperatures



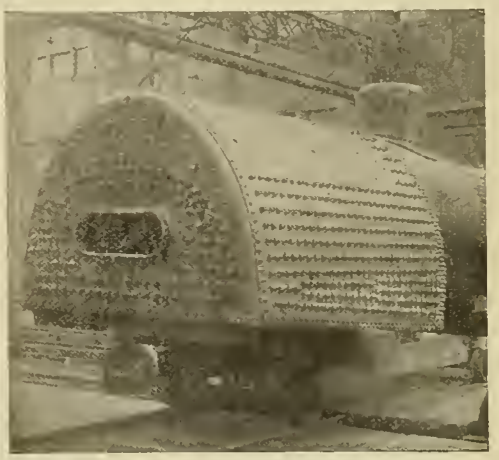
of working pressures, as during the period of firing up, when from the cold to the hot state of boiler, the differences in the amount of expansion is sufficient to seriously strain all parts rigidly connected subjected as they are to excess stresses, due to inequalities of sheet expansion.

The continual deterioration and consequent destruction of all materials involved in firebox assemblage, resulting in staybolts breaking, fire sheets distorting and cracking, and rivet seams leaking is due largely to rigid construction, as the strains induced by the stress of unequal expansion of sheets rigidly stayed, is too severe to warrant safe conclusions, and although quality of material is an essential safeguard in all cases of boiler construction, it fails, however, to cope with the alternating stress due to expansion in the locomotive firebox type of boiler, where the inequalities of sheet expansion are so severe under varying temperatures of boiler operation, that unless mechanical means are provided to accommodate the relative expansion of plates, destruction of material will result by reason of the resulting strains not calculated for. The use of the rigid staybolt for locomotive firebox construction in high pressure service, where sheet areas and heat-absorbing surfaces are subject to considerable expansion by reason of large dimensions and high temperatures, operates to restrict the natural course of the relative sheet expansion, especially in localities far removed from the neutral point in the firebox assemblage.

Flexible staybolts of various designs have been used to some extent for the past fifteen years, but little or no attention was given to them generally, by reason of faulty design and weak construction to meet satisfactorily the full requirements of firebox practice and service operation. Experiments, however, naturally led to modifications and the Tate flexible staybolt, which was brought to the attention of the railway world six years ago, has done more to establish the merits of the flexible staybolt and advance the methods of locomotive firebox staying to obtain satisfactory service results, than any other means known to former practice.

The Flannery Bolt Co., of Pittsburgh, manufacturers of the Tate flexible staybolt, has recently made a large addition to its factory to enable it to meet the increasing demand. The whole plant has been remodeled to more systematically handle all parts, and the several departments are driven by electric motors, divided into units, and most of the machine operations are done automatically, the forge department being most excellently equipped for the special work outlined.

Wheeling Locomotives.—In some of the shops with longitudinal pits it is sometimes impossible to clear the space reserved for wheeling the outgoing locomotives at the time when they are ready to be put on their wheels. In one shop this difficulty was avoided by clearing a space on the floor alongside the locomotive to be wheeled and set the wheels properly spaced and blocked just opposite their respective pedestals. The locomotive was then lifted by the crane and swung over and set down upon the wheels



far enough to permit a bar being slipped beneath the rims and across the top of the frame, but still without letting the weight of the boilers and frame rest on the axles. The blocking is then removed and the locomotive with its wheels suspended in this manner is set down upon the pit in the regular manner. The rods and piping can then be put up and other finishing work proceeded with until the space near the exit door is clear.

Standard Safety Appliances.—The Interstate Commerce Commission, on October 15th, issued its order for the uniform standards for the equipment of cars and locomotives with safety appliances, in accordance with the agreement already announced. This order applies only to new equipment. The commission states its intention to devise some plan regarding existing cars, which will not be burdensome. Secretary Moseley has been seriously ill since the day of the agreement regarding standards.

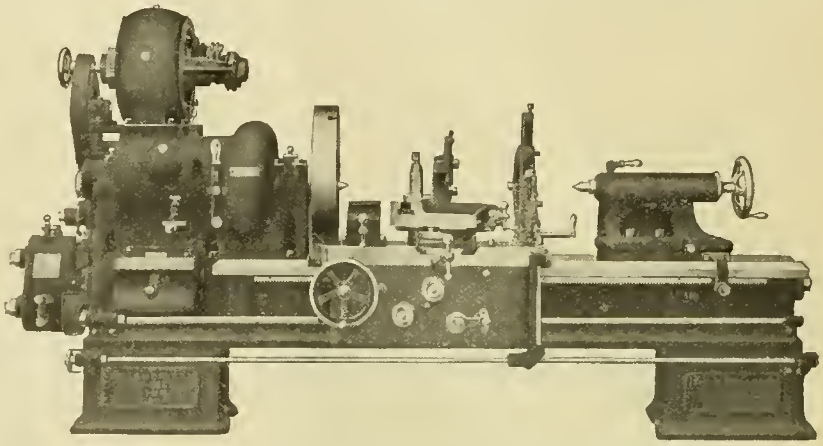
President James T. Harahan, of the Illinois Central Railroad, has confirmed the reports of his prospective retirement, naming January 12, 1911, as the date. "It is true," he says, "that on January 12 I shall have reached the age of seventy years and shall be retired automatically as president, according to the rules of our pension system."

New Steel Cars for the Lehigh Valley.—An order for forty all-steel vestibule passenger coaches has been placed with the Pullman Company by the Lehigh Valley Railroad. They are to be delivered in March and April of next year and will be put into service at once. In addition to these coaches, the Lehigh Valley has ordered from the Pullman Company two combination baggage-library-buffet cars, each 75 feet long and containing chairs for 23 passengers. These have all the appointments of the most modern car of that type, and. like the coaches, are steel throughout. It is announced that in the future the Lehigh Valley Railroad will follow the policy of having all its new passenger cars of fireproof construction.

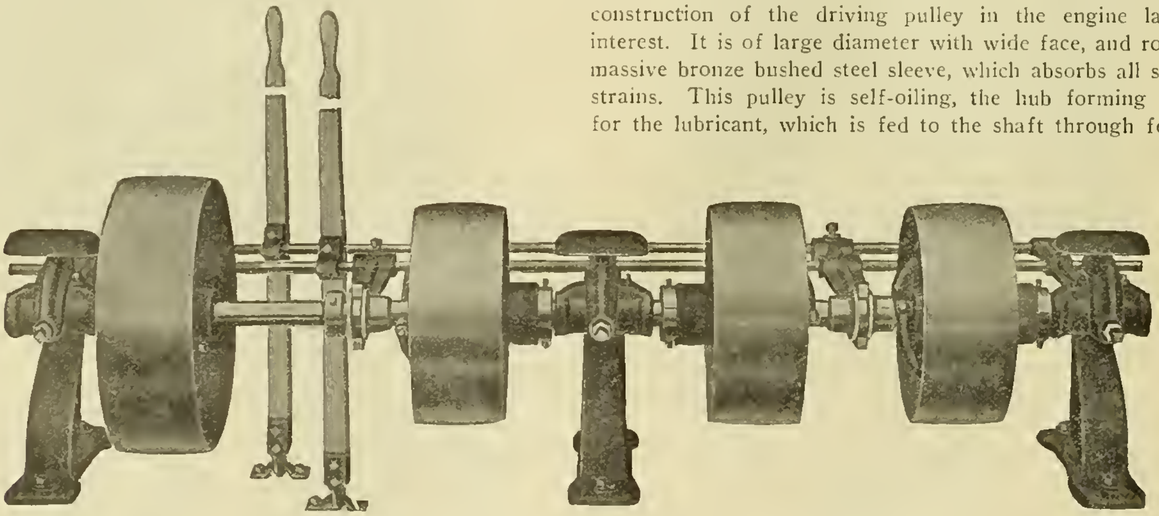
THE LATEST DEVELOPMENT IN ENGINE AND MOTOR DRIVEN LATHES

The exacting requirements of modern lathe construction have been well met in the two fine examples of engine and motor drives, which in sizes 14, 16 and 18 in. for the former, and 20, 24, 27, 30 and 36 in. for the latter, are the latest output in that line of the American Tool Works Co., Cincinnati, O. It would be, in fact, difficult to find a design which so adequately combines the necessary elements of heaviness and rigidity, and where the deflection of the bed, due to its own weight and the pressure of the cut, has been confined within such narrow and well designed limits that it need not be considered.

Despite the unusual strength, which is so plainly in evidence, these lathes present a remarkably clean-cut and finished appearance, which has been largely secured through an elimination of surplus stock where not required, and by augmenting the proportions of the parts where stresses are most in evidence. It has thus been possible to produce a very handsome and substantial tool, embodying unmistakable unbreakable features in connection with parts where failures usually occur, and with a capacity for continuous hard service at high speeds and heavy feeds.

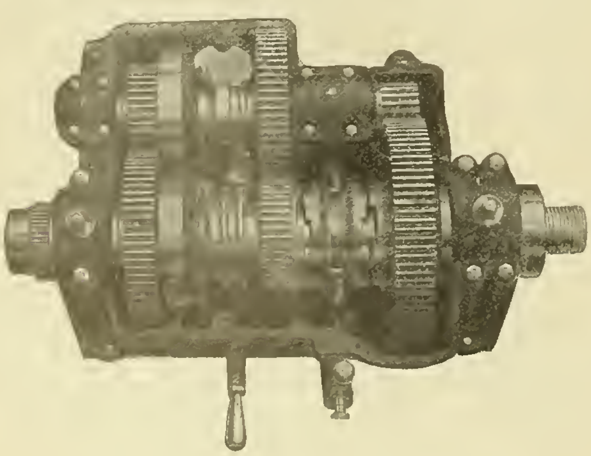


RIGID AND POWERFUL MOTOR DRIVEN LATHE.



TYPE OF COUNTERSHAFT USED WITH THE ENGINE DRIVEN LATHE

Several details of these modern geared head lathes merit a careful study, as representative of the highest present day development in machine tool design. One of the most important in this connection is that the frictions used in the geared head are of the manufacturer's double band type, the same as those which have accomplished such remarkable results with the American Tool Works Co.'s plain radial drills. Another prominent and much to be commended feature is the extreme simplicity of this head, there being only six gears to produce the mechanical speed changes.



ARRANGEMENT OF GEARS IN THE HEAD.

The same feature of simplicity applies to the counter shaft, which is regularly furnished with these lathes, and which affords two forward and one reverse, or three forward speeds. The construction of the driving pulley in the engine lathe is of interest. It is of large diameter with wide face, and rotates on a massive bronze bushed steel sleeve, which absorbs all shocks and strains. This pulley is self-oiling, the hub forming a retainer for the lubricant, which is fed to the shaft through felt wipers. This has proved to be an exceptionally excellent point, and has given general satisfaction.

Motor drive may be readily secured from the belt-driven machine at any time by removing the single pulley, mounting any type of variable speed motor on the flat place provided on the headstock, and connecting the motor to the driving shaft of the head through spur gearing. A motor may also be placed at the rear of the machine and connected to the driving shaft by either silent chain or belt.

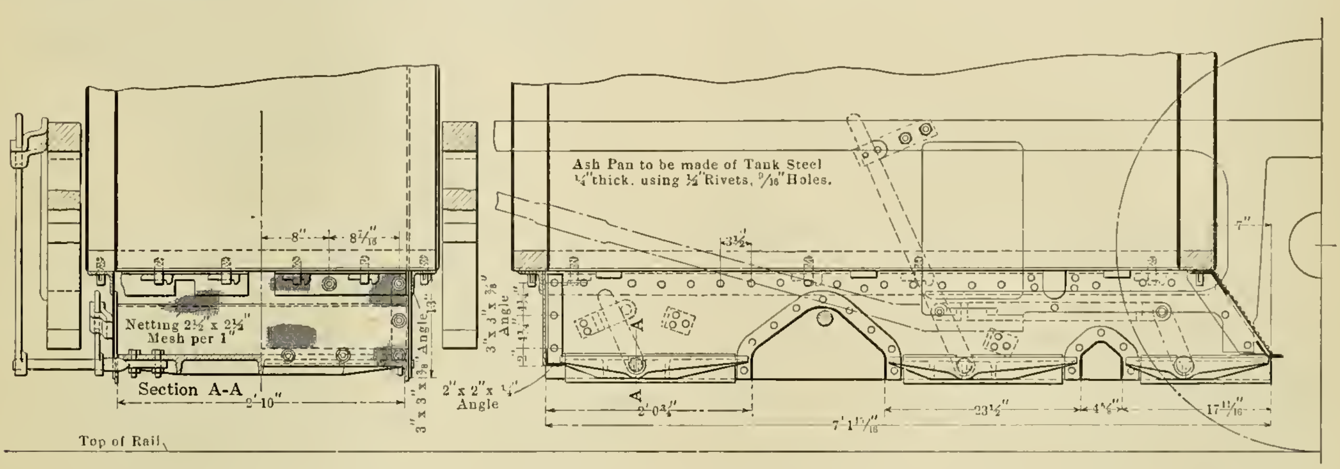
The larger motor driven lathe, 36 inch size, is of particular interest at this time when independent motor drive is being so generally applied to machine tools. To secure the proper spindle speeds for an electrically driven lathe, the most practical and economical method is to supplement the fundamental mechanical speed changes through convenient levers, with electric speed changes, advancing and receding by small increments at the will of the operator through a motor controller handle conveniently located. The controller handle in this design is located on the right end of the carriage, where it is always convenient for starting, stopping or reversing the motor speeds. A speed index plate shows the maximum and minimum spindle speed for each of the four mechanical speeds in the headstock, in connection with motor speeds, and indicates the positions of the two levers on the headstock for each mechanical speed change.

All gears on these lathes are cut from the solid with special cutters, and are of coarse pitch and wide face. Steel gears are liberally distributed throughout the machines where found necessary. Journals for spindle bearings are of bronze, and all gears are neatly covered. Rapid change gear mechanism provides a wide range of change for feeding and screw cutting, instantly available without the removal of a gear. The apron is "fool proof," it being impossible to simultaneously engage the feeds through the rod or screw. These lathes are built in even lengths of bed to any desired length.

SELF CLEARING SHALLOW ASH PAN

PENNSYLVANIA RAILROAD.

In addition to the ash pan designed by H. A. Hoke, assistant engineer of the Pennsylvania Railroad, to meet the requirements of the Federal laws, and which has been described and illustrated in this journal,* a patent has been granted to Mr. Hoke on one of another design, which is particularily applicable to locomotives requiring a shallow ash pan low down and between the frames. The new pan, herein illustrated, has been applied to several hundred engines of the Pennsylvania Railroad, replacing the original arrangement which embodied a solid bottom and front and back doors through which the ashes were raked.



SELF-CLEARING TYPE OF SHALLOW ASH PAN—PENNSYLVANIA RAILROAD

The drawing very clearly indicates the construction of the new pan which possesses the commendable feature of great simplicity with a minimum maintenance cost. With the exception of the dumping feature it follows the general design of the original pan, in fact it has been found thoroughly possible to rebuild the latter in this new form. The front and back doors have been replaced with netting, and the former solid bottoms with cast iron doors. It will be noted that these doors are supported on trunnions which are eccentrically located. These are journaled in the sides of the pan body, and are operated by levers extending to one side of the firebox. When convenient, the doors may be connected to one operating lever.

On account of the eccentric locking the operation of the doors, even when the pan is full, has been found comparatively easy, and the design in general gives very satisfactory results on the class of equipment where used.

A NEW CORROSION RESISTING METAL

Of the many subjects which are of interest to the sheet metal worker and the user of sheets there is none of such vital importance as the subject of corrosion. Manufacturers of sheets for a considerable time have been carrying on a series of exhaustive tests and experiments to produce a material which would be reasonable in price, meet all requirements, both as regards corrosion resisting qualities and working qualities; a material with which to combat and overcome the ever increasing prejudice against sheet metal for building purposes, a prejudice which has of late years been steadily increasing due to the unsatisfactory lasting qualities of a large majority of the materials which are now on the market.

The requirements have been successfully attained by the Stark Rolling Mill Co., of Canton, O., in its Toncan metal, the development of which had for guidance the methods of the old time ironmasters in the production of corrosion resisting material. It is an indisputable fact that this quality of the early sheets were due entirely to their uniformity or homogeneity, which was made possible through the proper selection of raw materials through the principle involved in their handling and through the care and attention with which the iron was made. Plenty of time was given the raw materials while in the furnace to eliminate any excess foreign impurities present and to properly combine those remaining, and also by handling the iron after it came from the furnace in such a manner that segregation did not take place during the reheating or working up processes.

Toncan Metal is classed as a metal rather than as iron or steel; because while it has corrosion resisting qualities equal to the old time iron, it also combined many characteristics of the highest grade mild open hearth steel, making it the ideal material with which to meet all requirements of modern sheet metal practice, in that it will not only withstand corrosion, but also the strains and stresses of shaping and forming without fracturing.

Indianapolis Railway and Mechanical Club.—This is the name of a new organization of mechanical men connected with the railways operating in the vicinity of Indianapolis, Ind. At the organization meeting, held September 14, the following officers were elected: President, F. C. Pickard, master mechanic, C., H. & D.; vice-president, C. M. Stark, general foreman, Indiana Southern; secretary, B. S. Downey, chief clerk to master mechanic, C., H. & D.

Car Heating in the Pennsylvania Electrified Zone.—For use during the cold weather when the trains of the Pennsylvania Railroad entering the New York station through the electrified tunnel zone are disconnected from their steam locomotives and taken across the Jersey meadows and through the tunnels by electric locomotives, steam generated in electric boilers will be used to maintain the temperature in the cars and keep the train connections from freezing. These boilers, which will utilize the 600-volt direct current from the third rail, are capable of generating steam at a pressure of 80 lb.

More Than 1,000,000 Tons of Iron Ore has been shipped from Bell Island mines, Newfoundland, this year by the Dominion Steel Corporation and the Nova Scotia Steel & Coal Company.

* See American Engineer, October, 1910, page 407.

SHOP WATCHMEN

The position of a watchman about railroad shops is one not ordinarily associated with much importance, therefore it is interesting to note the development which the Lake Shore and Michigan Southern has attained in connection with this particular classification of labor. In the organization of its motive power department,* the duties of watchmen have been arranged and systematized to such a thorough degree, that instead of the sinecure which the job ordinarily implies, the company has the services of trained and trustworthy men for work which is ordinarily characterized by laxity or even non-observance.

For instance, the chief watchman is practically in charge of an intelligence office. He telephones to and calls men from the shops in the instance of sickness or death at home; directs strangers through the plant when they come with the proper permit; receives hourly reports from the various subordinate watchmen scattered throughout the various departments; and last, but not least, conducts an employment bureau.

This last detail is quite interesting, as the hiring of all labor is largely under control of the chief watchman's office. Each foreman sends a daily notification of his particular needs, and as applicants present themselves they are questioned regarding their experience, ability and age, and if thought to be acceptable are sent under the conduct of a watchman to the foreman handling their particular line of work. It will be recalled in this connection that a great many shops in this country can be entered almost at will, and that many foremen with their valuable time fully occupied are compelled to waste no inconsiderable part of it discussing with obviously unsuitable labor which should have had a preliminary weeding out at the shop-gate.

The subordinate watchmen have routine duties sufficient to occupy them throughout their night or day trick, but not so exacting as to prevent them from taking the necessary time to study a condition which might be improved to the company's benefit. In particular they are charged to take every possible precaution against fire. There are 102 fire alarm stations in the Collinwood shop, 43 fire hose stations, and 49 fire hose reels, all of which are carefully examined every day and receive a general inspection by the watchmen every week, each inspection being a matter of record.

As would naturally be expected in this complete organization, each watchman's report of his trick concisely portray the conditions. These are made on a standard form, which in addition to the fire protection mentioned, provide for reporting lights out of order, leaky steam and water pipes, and a space in which to cite conditions not enumerated, such as accumulations of dirt, broken window glass and doors, and in fact anything which might appeal to the watchman as implying laxity or deterioration. The night men use the clock system, ringing at hourly intervals, while the day men are in constant communication with the chief watchman's office by telephone, advising him of their movement, and reporting anything which requires immediate attention.

Making what may be called a real job of one in which the duties are generally regarded as perfunctory has accompanied the putting into operation of a few of the modern large plants, principally Collinwood and Angus, and its success is such that it merits careful consideration. Heretofore much of the important work which now devolves upon the watchmen was supposedly looked after by the several foremen, and many of us are well aware how it was usually slighted, because each foreman had his time fully occupied in securing the output of his shop.

The larger railroad terminals include shops which have grown to cover many acres, and their careful policing, both within and without, is an essential detail which this admirable system appears to satisfactorily solve.

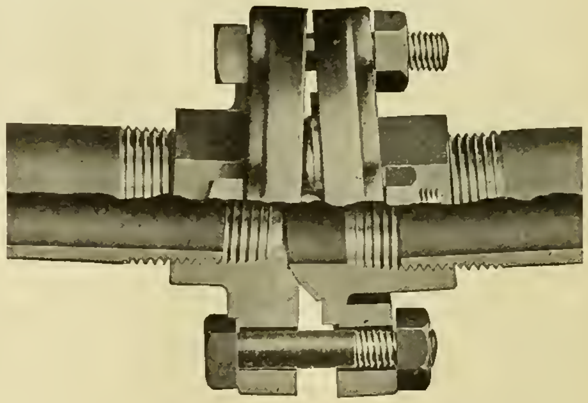
THE DETROIT RIVER TUNNEL of the Michigan Central Railroad was opened to regular passenger service October 16.

* See AMERICAN ENGINEER, December, 1908, page 453.

FLANGE UNIONS WITHOUT PACKING

The distinguishing features of the flange union manufactured by the Jefferson Union Co., of Lexington, Mass., are the loose collar and the spherical brass to iron seat which requires no packing. The loose collar permits the opposing members of the union to be screwed on the pipe to just the proper position without the necessity of bringing the bolt holes directly opposite. The collar can then be turned around until the bolt holes are in line. It will be noted that the two end members are made hexagonal in shape so that they can be readily grasped with any kind of wrench.

The most interesting detail is perhaps the construction of the gasketless seat. Both the convex and concave members are



spherically ground to a perfect fit, so that no matter at what angle the connection is made a tight joint will be secured and the pressure in drawing up the union will be at all times normal. In the concave face a narrow channel is cut and a ring of drawn brass tubing is so firmly embedded that it becomes practically one piece with the iron. This brass ring projects slightly above the surface of the iron and is ground to fit the convex face of the opposing member. This brass-to-iron joint is non-corrosive, and a fitting may be set up and taken apart and reset again any number of times without injury.

The union illustrated here will successfully hold pressures to 300 pounds. Two heavier fittings are made, styles "D" and "E," both of which are heavily bolted and guaranteed to stand a working pressure of 3,000 pounds per square inch.

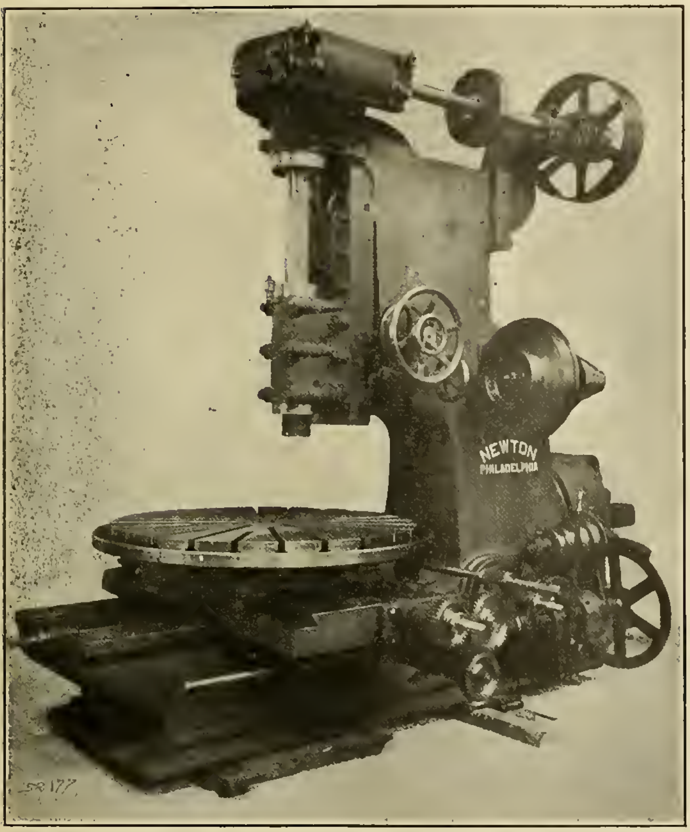
A RAILWAY TO HUDSON BAY.—It is said that at a conference between W. Mackenzie, D. D. Mann and W. H. Moore, of the Canadian Northern Ry., and the Minister of Railways, at Ottawa, September 23, the question of the railway from The Pas, Sask., to Hudson Bay was under discussion. Press reports state that a proposal for the leasing of the line, when built by the Dominion Government, to the Canadian Northern Ry. on an agreement similar to that with the G. T. Pacific Ry., for the operation of the National Transcontinental Ry., Eastern Division, was proposed, but the Minister of Railways said there was nothing of a definite character suggested or considered in regard to the line.

THE VOLATILE MATTER OF COAL is the title of the first bulletin to be issued by the new Federal Bureau of Mines. The authors, Horace C. Porter and F. K. Ovitz, conducted their investigations at the Pittsburg station while it was under the Technologic branch of the Geological Survey, the work being a continuation of the fuel investigations begun several years ago at the Louisiana Purchase Exposition, St. Louis, Mo. The bulletin will be of interest to fuel engineers, designers and builders of gas producers, gas and coke manufacturers, superintendents of power plants, railway master mechanics and those engaged in the suppression of smoke. It may be obtained by applying to the Director of the Bureau of Mines, Washington, D. C.

POWERFUL VERTICAL MILLING MACHINE

The extensive and growing use of milling machines in railroad shops has resulted in a striking development of this comprehensive tool, as well as an enlargement of its scope of usefulness rather startling to contemplate when contrasted with its rather limited field of only a few years ago. In particular heavy milling operations are now undertaken on such a scale that the production of a tool to meet the exacting requirements presents a most interesting problem in machine design.

A new design of vertical milling machine of exceptionally rigid construction throughout, manufactured by the Norton Machine Tool Works Co., Inc., Philadelphia, Pa., is shown in



VERTICAL MILLING MACHINE OF GREAT POWER

the accompanying illustration, and embodies features which are a radical departure from any existing bevel or spur driven machines.

The spindle is 6⅜ in. dia. in the main bearing, which is bronzed bushed and capped, and is 21½ in. long. The driving worm wheel is of very large diameter, and has a bronze ring with teeth of steep lead. The sleeve is cast solid and revolves in a bushed capped bearing, which is bolted to the top of the frame to permit of adjustment should it ever be required to maintain alignment, if the wear has to be compensated for. The maximum distance from the end of the spindle, which is made to rotate with the sleeve by means of a double key way, to the table is 22 in.; length of in and out feed, 33 in.; length of cross feed, 33 in., and distance from center of spindle to upright is 34½ in. The extreme height of the spindle in its highest position is 12 ft. 6 in. A notable feature in connection with the top of the spindle provides a simple design for the attachment of the swinging crane, and also protects the top of the spindle and the driving mechanism from dirt. The spindle saddle is counterweighted; it has square lock gibbed bearings on the upright and adjustments are made by means of taper shoes.

The drive is taken from a General Electric D L C 50, 220 volt, 30 h. p. motor, having a speed of from 400 to 1,200 r. p. m. through a 7-in. belt to the pulley which revolves on the finished end of the bearing in order to give a larger substantial wearing surface. The rotation of the shaft is obtained by keying a large washer on to the shaft which has a broad face key extension fitting into a corresponding slot in the end of the pulley hub. The driving worm is of hardened steel fitted with roller thrust bearings, both of which are bushed and capped. The driving worm and worm wheel are entirely encased, permitting continual lubrication.

Motion for the feed is taken from the intermediate shaft pulley to the two step cone, to which is attached a four step cone of smaller diameter, which is belted to one of equal proportions below. The illustration indicates very clearly the arrangement of these parts. It will be noted that the motion is further transmitted through the large gear, which rotates freely on the horizontal driving shaft and feed can only be obtained by the engagement of the adjacent lever. When this latter is in its opposite position fast traverse is available. The feed and fast power motion are further carried through the double train of bevel gears giving reverse to both motions for the circular, in and out, and cross movements. All gears on this machine are of steel or bronze, and all movements are clutched.

The circular table which is 60 in. in diameter over the "T" slots, and of very heavy construction, is entirely surrounded by an oil pan and has an exceptionally large central bearing in the table saddle. This machine is particularly intended for locomotive work, permitting the heaviest possible cuts, and the intention in the design is to secure as efficient results as can possibly be obtained from this company's plainer type machines, on which they are already removing one cubic inch of metal per h. p. The machine occupies a floor space of about 12 ft. 2 in. by 8 ft. 5 in., with an extension of 5 ft. in the rear when arranged for motor drive.

The Pennsylvania Railroad Company has for many years past, as a result of its operations, realized a substantial surplus in each year over and above the amount required to enable it to meet its interest charges and pay moderate dividends on its stock to its stockholders. This surplus has varied in amount from year to year. For the last ten years the average has been about $12,000,000 a year, practically all of which has been expended on the property for the purpose of enabling the company to conduct its operations more safely, more efficiently and more cheaply.—*President McCrea before the Interstate Commerce Commission.*

New Passenger Depot for Sacramento.—The Southern Pacific has appropriated $400,000 with which to erect a new passenger depot in Sacramento, Cal., next year as soon as the new bridge now under construction across the Sacramento River is completed. In addition to the cost of construction the final price will be run up to $500,000 because of the furniture and elaborate finishings, which will make the structure one of the finest stations on the coast.

The Harriman Lines spend very large sums on repairs of equipment and keep their equipment in correspondingly good condition. During 1910 there was a net increase of 46 locomotives in service, 114 passenger train cars and a decrease of 421 freight train cars in service. On June 30 there were 28.93 per cent. of the locomotives in service in thorough order; 41.71 per cent. in good order; 18.34 per cent. requiring repairs, and 11.02 per cent. in shop.

Steamship Terminal at Montauk.—Last month the transportation world was enlivened by a report to the effect that plans were in negotiation by the White Star Line which, if carried through, would make Montauk Point, one of the most Eastern points of Long Island, the American terminal for the great steamships.

NEUTRALIZATION OF STRESSES IN LOCOMOTIVE FIREBOXES

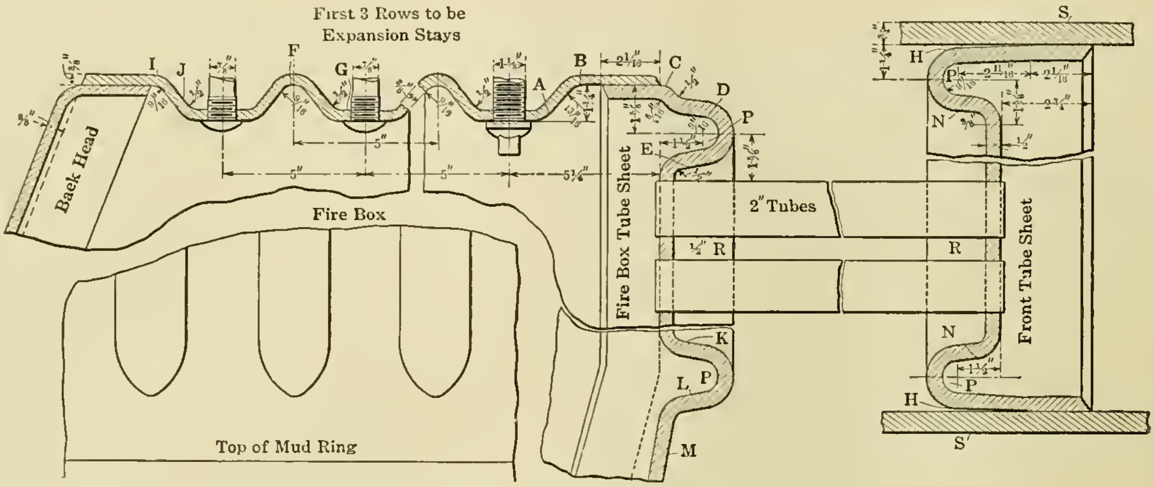
The long continued debate of many years between mechanics in general, in which the rigid staybolt and its constant breakage formed the basis of the discussion, served to establish the superior advantages possessed by the flexible stay, but the principal point—too rigid boiler contruction—which is probably the real cause for so many staybolt failures, has been largely overlooked or lightly touched upon.

It is an unquestioned fact that rigid construction is largely, if not entirely, responsible for leaking rivet seams, firebox sheets distorting and cracking, broken bolts, and continued deterioration of all materials involved in firebox assemblage. The introduction of the flexible staybolt has, of course, done much to right the abnormal conditions which formerly prevailed in connection with the maintenance of fireboxes in service, but its success has not prevented a consistent effort on the part of designers to eliminate the real troublesome feature of rigidity. Toward the attainment of this much-to-be-desired end many devices have been evolved in this and other countries, but, with few exceptions, including that herein illustrated, all were lacking in practical value, and interesting only through novelty in design. The Wood firebox and tube plate arrangement, however, embodies a common sense and practical arrangement, to which the drawing convincingly attests.

It may be briefly mentioned that in referring to this drawing the capital letters marked thereon, with the exception of ("P") ("R") and ("S") indicate the points where expansion and contraction are provided for and neutralized in this form of firebox and tube plates. The letters (F) and (G) refer to formation of corrugation where expansion takes place. The sections of this character have a corresponding deflection, which is sufficient to equalize the tension on the stays.

These various points so indicated are worthy of very careful study. They were determined following the results of a long series of experiments and research into the distribution of stresses, and their formation is intended to serve as a compensating feature for all deformations which must ensue under the ordinary construction. For instance, the arrangement of the tube sheets in the Wood boiler is particularly appealing in that the trouble experienced in regular firebox tube sheets, in extending the tube sheet upwards over the crown sheet, and which is attributed to expanding the tubes from time to time, could not possibly take place, in this design, in the section marked (C) (D) and (E). The extension of the tube sheet at (C) upwards, through the action of the expander, must necessarily be released by the spring of the corrugation marked (P).

From the front tube sheet and firebox tube sheet, each of which have the same leverage on each corrugation which encircles the tubes, it will be seen that the tube sheets (R) are stronger for carrying the tubes and more flexible for allowing their expansion *en masse*. As the expansion of the tubes is in the direction of the firebox tube sheet, the front tube sheet is formed to take care of vertical or horizontal spring at (H), which will not allow the corrugation (P) to come in contact with the boiler sheet (S). The expansion of the tubes coming from the front to the firebox tube plate is released by the spring in corrugation, as in the expansion of the firebox, which would come towards it if not neutralized by formation between each row of staybolts.



FLEXIBLE CONSTRUCTION OF LOCOMOTIVE FIREBOXES AND TUBE SHEETS

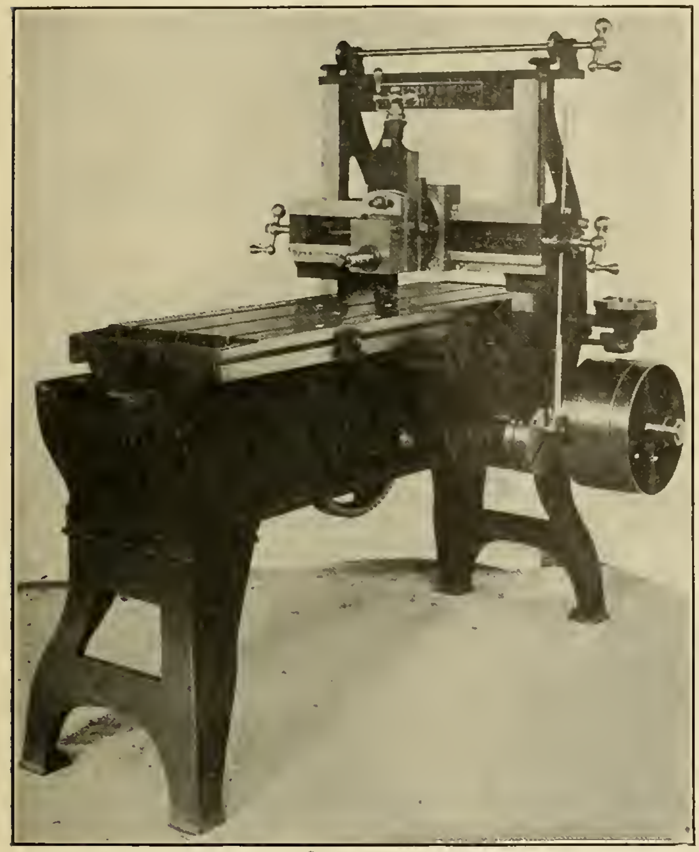
The tension on the mud ring side of the throat sheet will be released to some extent by the spring of the corrugation at the front (L), directly above the throat sheet (M). This has proved itself by allowing the stays on the throat sheet to remain tight and with none broken or leaky after a service of nearly two years on the road. The mud ring on the sides and front by this formation is practically free from the expansion pull towards the firebox tube sheet, whereas if they were not in this formation and straight sheets had been used, the pull would be in direct lines from the mud ring towards the firebox tube sheet, which is the hottest part of the firebox. Attention is called to the back head of the firebox being connected by formation marked (I) and (J), encircling the crown and side of the firebox tube sheet so that the expansion and contraction may be neutralized between the points (A), (B), (C), (D) and (E).

There can be no question but that a firebox in one sheet, as realized in this construction, is better for neutralizing strains than one made with three sheets. The firebox in this latter and usual arrangement must necessarily have a riveted seam on the joint at each side, which prevents the strains from being neutralized through the strength of the riveted seam, which virtually acts as a longitudinal stay between the firebox flue sheet and the back firebox sheet.

One Man Locomotives in Sweden.—The Swedish State railways are at present contemplating the adoption of a one-man locomotive for distances with a limited local traffic, and a commencement has already been made over the Orebro-Adolfsberg line. The name, one-man locomotive is, in a way, a misnomer, inasmuch as the driver is not meant to manage the locomotive entirely alone, but the fireman has also to act as guard, collect tickets, etc., or the guard undertakes the duties of fireman, whichever way one may choose to put it. The Swedish State railways have bought ten locomotives with this service in view. This method has been used in other countries, more especially in Germany, for some time and with satisfactory results.

A SMALL PLANER WHICH CAN BE ADAPTED TO A WIDE RANGE OF REPAIR WORK

Although a considerable amount of work, which up to a few years ago was always handled by a planer or shaper, has been turned over to the milling machine, there is still much remaining which needs to be performed on those two tools. This particularly applies to certain features of railroad shop repair work where a small and compact planer becomes an indispensable tool



for the replaning of shoes and wedges, engine truck boxes, crosshead gibs, guide bars and even driving boxes. Two or more such tools will generally be found as an accompaniment to the machine shop of the most recent plants.

A design well adapted for these requirements is the new 16 in. by 16 in. by 3 ft. planer by Schneider and Goosmann, of Cincinnati, O., herein illustrated. It is a well proportioned and substantially built machine which can be run profitably on a wide range of work which would entail a loss of time and needless waste of power if assigned to the larger machines.

The table measures 3 ft. inside the scrap pockets and has a steel rack 4 ft. long, thereby allowing work longer than 3 ft. to be planed if necessary. A clamping device is also provided to prevent the table from lifting when planing extreme lengths. These clamps are located on the inside of the bed, at the center, and bear upon grooves cut in the table just above the V's. The T slots are cut from the solid and four rows of holes are drilled and reamed for ⅝ in. studs.

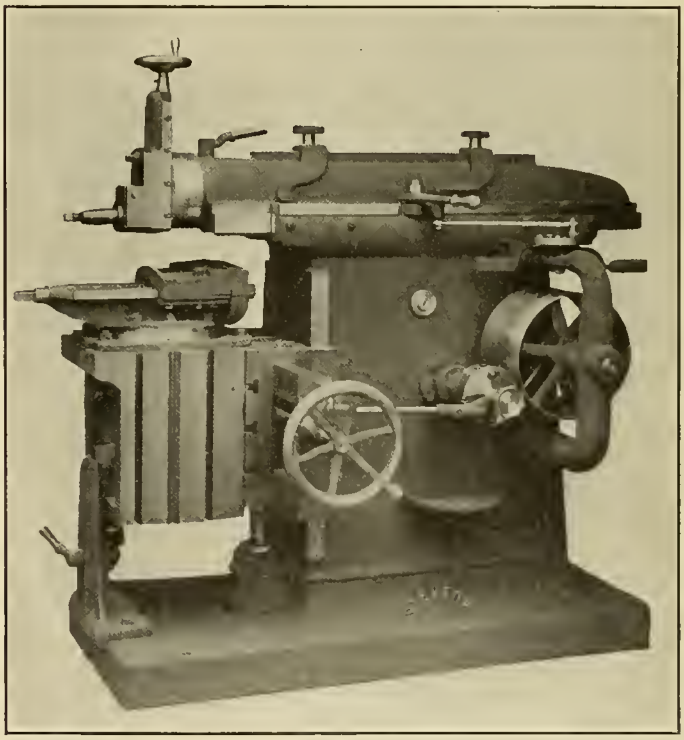
The belt shifting mechanism moves one belt entirely off the tight pulley before commencing to move the other on. A safety plunger is provided to prevent the accidental starting of the planer when the driving belts are running on the loose pulleys. The ratio of belt speed to cutting speed is 32 to 1. Width of belts 1¼ in. The countershaft has tight and loose pulleys 6 in. diameter by 2⅝ in. face. The fly wheel is 11 in. in diameter and acts as a reversing pulley; the other pulley is 5 in. diameter. All parts of the machine are well finished. The shafts are made of high grade machinery steel. The head and cross rail, as well as the housings, are exceptionally strong, and have wide surfaces, all scraped to a fine bearing. The saddle is graduated and the tool slide has an exceptionally long range and has a micrometer dial on the feed screw. The weight of the planer complete with countershaft and wrenches is about 1,150 lbs.

TWENTY-SIX INCH TRIPLE GEARED SHAPER

Prominent among the very interesting new machine tools which have been lately brought out is the new 26 in. triple geared shaper, by the John Steptoe Shaper Co., of Cincinnati, O. This tool was designed to meet the most exacting requirements which can be imposed upon a shaper, and it embodies many distinctive points of merit which invite attention.

For instance, the ram is driven by two rack gears of large diameter, and the rack is cut from solid steel, thereby avoiding the excessive jarring at each end of the stroke, and giving an even pushing strain on both gears. The use of two gears permits the passing of bars through an opening in the top of the column for key seating, which cannot be done where only one large gear is used.

The vise has a graduated swivel base, which is turned at any angle to thirty degrees, so that it can be easily read by the operator. The upper jaw of the vise grips firmly around the lower jaw, thereby preventing the upper jaw from raising when the work is being tightened in the vise. Two additional clamping bolts are provided which project through the upper jaw of the vise, and which can be fastened where extreme accuracy is



necessary, as they will overcome the tendency of the upper jaw to raise when the work is being fastened. The head can be very quickly loosened and swiveled to any angle by pushing the lever at the back of the head, and can again be instantly fastened by pulling the lever toward the operator.

This machine is geared at the rate of about 42 to 1, and is made to take very heavy cuts with high speed steel. The column, ram and base are very heavily ribbed and braced and all bearings are of the most substantial dimensions. Those of the shaft in the column are bushed with cast iron, and have ring oilers, and the shafts are turned with spiral oil grooves to insure the proper distribution of oil over the entire bearing. All wearing surfaces are provided with flat gibs, and the screws for adjusting the gib in the ram and hasp slide have lock nuts to prevent their moving. The lead screw and hasp slide screw are provided with hand wheels, which will be found very convenient

The Railroad Clubs

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Dec. 6	The Modern Railway	Edwin F. Wendt	Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	Jan. 13	....	....	H. D. Vought	95 Liberty St, New York
New England	Dec. 13	The Evolution of Air Brakes	H. N. Lamb	G. H. Frazier	10 Oliver St., Boston, Mass.
New York	Dec. 16	Annual Entertainment and Smoker	....	H. D. Vought	95 Liberty St., New York
Northern	Dec. 24	Interchange of Cars	Wm. Durgin	C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	Dec. 23	Testing of Coal	H. M. Wilson	C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	Dec. 9	Work of the Weather Bureau	....	F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	Jan. 19	....	....	A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	Dec. 9	....	....	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Dec. 19	....	F. S. Sheafe	J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	Dec. 12	....	A. Wilcox	W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

THE TRAINING OF APPRENTICES

CANADIAN RAILWAY CLUB.

At the October meeting P. McLaren, machinery expert of the Grand Trunk Railway, presented a paper, entitled, "Some Thoughts on the Training of Apprentices." The author has had considerable experience in this line of work and gave some very interesting opinions on the method of properly handling it. He does not believe that compulsory education right through is the proper method. He does, however, believe in making attendance at the classes for the first year compulsory and allowing those to drop out who apparently do not have the necessary mental equipment for future progress, still allowing them, however, to continue with their shop work. He recommended holding all classes in the day time. The paper included a brief outline of the proper course of progress for an apprentice, and also briefly outlined the scheme followed on the Grand Trunk Railway.

The paper was discussed by Mr. Powell, who took issue with the author on a number of features. H. Martin Gower, superintendent of apprentices on the Canadian Pacific Railway, after complimenting the paper most highly, stated that he believed that the most important training a boy should receive is the development of character, then common sense and lastly knowledge of skill in his trade.

Following this a number of members took occasion to discuss the subject and considerable information concerning the apprentice work in foreign countries was brought out. H. Lacey Johnson evinced great interest in the subject and spoke at some length in favor of the work now being done along these lines

AN OFFICIAL'S RELATION TO HIS MEN

NORTHERN RAILWAY CLUB.

At the October meeting, Thomas Owens, superintendent of the Duluth & Iron Range Railroad, Two Harbors, Mich., presented an interesting paper discussing the features of an official which made him successful and popular. He drew attention to the many small things, usually unimportant in themselves, which often resulted in the failure of a man in an official capacity who apparently was particularly well suited for the work. The paper might be summed up in the recommendation to those occupying official positions for the close study and practice of the following qualities: justice, tact, kindness and decision.

FLUE FAILURES

WESTERN RAILWAY CLUB.

J. W. Kelley, foreman boiler maker, Chicago & Northwestern Railway, presented at the November meeting of this club the most interesting and valuable paper on the above subject in which he pointed out the causes of many of the flue failures, some of which have been largely overlooked, and explained a number of methods that had been tried in his shop to overcome these difficulties and the success that had been attained. This paper is too valuable and extensive to be fully reviewed in this place and will be presented in abstract in a later issue.

EDUCATIONAL BUREAU OF THE UNION PACIFIC RAILROAD

CENTRAL RAILWAY CLUB.

Dexter C. Buell, chief of the bureau, presented a paper at the November meeting of the Central Railway Club in which he pointed out the reasons for the organization of the educational bureau and briefly recounted the principles on which it was founded, its method of operation and the results that had been obtained after about a year's experience.

In the October, 1909, issue of this journal, page 392, will be found a brief description of this unique departure in railroad educational work. At the present time Mr. Buell states that the work of the bureau covers the following courses:

- Block Signal Maintenance and Operation.
- Interlocking.
- Signaling.
- Elementary Electricity.
- Electric Light and Power.
- Telegraphy.
- Telephony.
- Railroad Operation.
- Train Operation.
- Station Work.
- Railroad Accounting.
- Freight Traffic.
- Passenger Traffic.
- Analysis of Statistics.
- Track Work in English.
- Track Work in Japanese.
- Surveying and Mapping.
- Railway Civil Engineering.
- Railway Mechanical Engineering.
- Locomotive Course.
- Air Brake Course.
- Gas Engines.
- Motor Cars and Motor Car Operation.
- Mechanical Drawing.
- Sheet-Metal Pattern Drafting.
- Boiler Construction and Repairs.
- Machine Design.
- Refrigeration.
- Car Building.
- Car Repairing.
- Shop Practice and Plumbing and Pipe Fitting.

Although no attempt has been made to push this work among the employees, over 1,600 have already asked for assistance and of these 80 per cent. are at present in good standing with the bureau. The scheme of the work is along the lines of the correspondence school, and it has been found necessary to originate many text books.

RAILROAD RELIEF DEPARTMENT

NEW YORK RAILROAD CLUB.

Joseph N. Redfern, superintendent of the relief department of the Chicago, Burlington & Quincy Railroad, read a paper at the November meeting of this club discussing the importance, value and the results of a properly organized relief department, choosing the one on the Burlington, which is generally recognized as being among the best, as an example. The paper also touched upon the comparative justice of the two acts which are now being agitated before Congress, entitled the "Employers' Liability Act" and "The Workman's Compensation Act."

On the Burlington Railroad a little over 50 per cent. of the employees are members of the relief department and about 85 per cent. of the permanent force are members. Practically all of the engine and train men have joined and the average death benefit carried by them is $1,475. They carry an average daily benefit of $1.70 per day. The members are carrying $23,000,000 death benefit and $1,500,000 general accident death benefit.

During the 21 years of the existence of this department the railroad company has expended $1,350,000 in paying operating expenses, which however does not include a large number of items that are ordinarily included in operating expenses of a department, for instance, office rent, work done by employees of other departments, etc.

The annual reports of the secretary and treasurer of the club show a present total membership of 1,566 and an entirely satisfactory financial condition.

H. S. Hayward, superintendent of motive power of the New Jersey Division of the Pennsylvania Railroad, the newly elected president, was inaugurated at this meeting.

BOOK NOTES

The Indicator Handbook. By Charles N. Pickworth. Cloth, 142 pages, 5 x 7½ inches. Illustrated. Published by D. Van Nostrand & Co., 23 Murray street, New York. Price, $1.50.

This excellent little work constitutes a simple and eminently practical analysis of the principles, construction and operation of the steam engine indicator, and is to be commended for the clearness of its style in handling the subject from every point of view. Interesting chapters are included on errors of the indicator connections, of the reducing rig, and of the indicator, all of which are subjects which merit more attention than they have hitherto received. The book also contains a separate chapter devoted to the use of indicators in connection with gas and oil engines; while optical indicators, pressure indicators, etc., are also given attention.

Machine Drawing. By Gardner C. Anthony. Cloth, 160 pages, 6 x 7½ inches. Illustrated. Published by D. C. Heath & Co., 120 Boylston street, Boston, Mass. Price, $1.50.

The first edition of this book was very widely used in engineering schools of the better sort, and the improvements which the present edition represents should commend it to a still larger number of those interested in the subject. It has been the aim of the author to teach and encourage the use of concise, graphic terms by adopting the idiomatic phrases of the engineer, and to suggest many useful means for acquiring facility in this form of expression. The system of projection taught is that which the best practice demands, and examples have been selected with a view to establishing its principles with the least expenditure of time. The solution of geometric problems is required by practical methods in use by draftsmen, as well as by the ordinary geometric construction. In particular the graphic statement of problems, which gives a definite layout, is a great labor saving device for both instructor and student. The book contains 196 illustrations and 228 problems.

The "Mechanical World" Pocket Book and Year Book for 1910. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. 388 pages, 4 x 6, illustrated. Price 12 cents.

This is the twenty-fourth edition of this valuable little work, and it is fully equal in every way to the high value which has been set upon its predecessors. The book deals comprehensively with the usual engineering questions of design, construction and operation of machinery in general. There is a lengthy section on the shapes, speeds and feeds of cutting tools, with supplementary sections dealing with milling cutters and twist drills. Entirely new sections on standard screw threads, high speed steel and its treatment, and constructive details of gas engines have been added since the last edition, and several additions have been made to the many useful reference tables with which the book abounds. It contains also a most complete index and a diary and memoranda of about 60 pages for 1911.

"The Effect of Keyways on the Strength of Shafts," by Herbert F. Moore, has just been issued as Bulletin No. 42 of the Engineering Experiment Station of the University of Illinois. This bulletin gives the results of tests to determine the relative strength of solid shafts and of shafts with keyways. A table showing power tansmission by cold-rolled shafting with keyways and a diagram illustrating the weakening effect of keyways are given. Copies of Bulletin No. 42 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

COMMUNICATIONS

ENGINEERING VS. GUESSWORK.

To the Editor:

In the November issue of the American Engineer regret is expressed that the reporters on boiler design at the Railway Congress did not assign reasons for their preferences toward the round-top or Belpaire boilers. If these reasons had been frankly given, would they not have read something like this: "On the X. & Y. R. R. they had some trouble in the corners of some fireboxes of this type" (which may, or may not, have been well designed), and "Mr. ——— thinks this or that shape about right." How many roads have reached the decision after a thorough investigation of the availability and cost of maintenance of the whole firebox ends of an adequate number of boilers of each type in the same service, there being every reason to believe that each is the best of its type? Yet firebox troubles are acknowledged to be the great source of expense and delay in the motive-power department.

Is this not one of many cases in which the unwillingness to investigate may be causing much needless expense? The concentration of attention upon the business aspects of the motive-power problems have so far superseded interest in them as engineering questions that the investigations are superficial. Then many reports to the Master Mechanics' and Master Car Builders' Associations consist largely of tabulations of practices of the different railroads, established as indicated above; and practice of the majority prevails as "having stood the test of practical experience." It is the belief of the writer that considerable expense could be saved on almost any railroad by more thorough and more independent engineering. G. E.

POSITIONS WANTED

Chief Draftsman, Mechanical Engineer, Erecting Supervisor or Assistant.—Man with sixteen years experience in railroad motive power departments; 10 years served as draftsman and chief draftsman, and 6 years in present position as erecting and machine shop inspector in both car and locomotive departments. Address X. Y. Z.

Designing Engineer.—A first-class designing engineer on locomotive works, or tools and equipment. Familiar with modern shop methods and thoroughly original in ideas. Address C. V. F.

Car and Locomotive Draftsman.—Man with short experience on railroads and with car building companies wishes position as draftsman where opportunities for advancement are satisfactory. Address H. E. E.

Shop Foreman.—A practical man whose experience includes drafting room, roundhouse, erecting shop and machine shop work, and who is now foreman of one of the best and most efficient shops in the country, desires a better position where ability will receive reward. Address F. G. Q.

Mechanical Engineer or Chief Draftsman.—Long experience in the drafting room of railways; at present chief draftsman; wishes position on a southern railway. Address P. F. R.

Draftsman.—Young man with two years' experience in railroad shop and drawing room desires a position in the west. Address J. C. H.

PERSONALS

W. F. Lowe has been appointed road foreman of engines of the Alabama Great Southern R. R.

F. B. Childs, master mechanic of the Northern Pacific, with office at Spokane, Wash., died at Spokane last week.

C. T. Ripley has been appointed assistant engineer of tests of the Atchison, Topeka and Santa Fe Ry. at Topeka, Kan.

B. Hoffman has been appointed assistant engineer of tests of the Atchison, Topeka and Santa Fe Ry. at Topeka, Kan.

D. E. Sullivan, master mechanic of the Union Pacific R. R. at Evanston, Wyo., has had his office removed to Green River, Wyo.

Geo. Donahue, formerly superintendent of the Readville shops of the New York, New Haven and Hartford R. R., has resigned.

Rudolph Ellzey has been appointed master mechanic of the Kentwood & Eastern Ry., with office at Kentwood, La., succeeding John May, resigned.

F. E. Marsh, assistant master mechanic of the Pennsylvania R. R. at Trenton, N. J., has been transferred to the machine shops at Altoona, Pa.

S. T. Harris has been appointed foreman of car shop at Pratt City, Ala., on the Birmingham Southern R. R., succeeding H. W. Howell, resigned.

B. M. Angwin has been appointed master car builder of the Birmingham Southern R. R., with office at Pratt City, Ala., succeeding J. N. Collins, deceased.

Geo. Whiteley has been promoted from road foreman of engines to master mechanic of District 1, on the Saskatoon division of the Canadian Pacific Ry.

J. L. Butler, master mechanic on the White River division of the St. Louis, Iron Mountain & Southern Ry. at Cotter, Ark., has been transferred to Crane, Mo.

F. A. Chase, formerly general mechanical inspector of the Chicago, Burlington and Quincy R. R., has retired after almost 61 years of continuous service.

S. R. Richards, general inspector of the New York, New Haven and Hartford R. R., has been promoted to be shop superintendent of the company's New Haven shops.

C. R. Dobson has been appointed general foreman in the car department of the Rock Island Lines, with office at Cedar Rapids, Iowa, succeeding C. Setzekorn, resigned.

G. H. Watkins has been appointed an assistant master mechanic of the Pennsylvania Railroad, New Jersey division, at Meadows, N. J., succeeding Edwin Schenck, Jr., promoted.

E. B. Gilbert, having resigned the office of superintendent of motive power of the Bessemer and Lake Erie R. R., has been appointed special agent of the motive power department.

H. C. Oviatt, master mechanic of the Western Division of the New York, New Haven and Hartford R. R., has been promoted to be general inspector, with headquarters at New Haven.

Louis Fleischbein has been appointed shop superintendent for the Western Pacific R. R. at Sacramento, Cal. He was formerly general foreman of the Chicago & Alton shops at Bloomington, Ill.

J. F. McDonough has been appointed master mechanic of the Middle division of the Atchison, Topeka & Santa Fe Ry., with headquarters at Newton, Kan., vice Mr. E. E. Maclovec, transferred.

Chas. D. Chandler has been appointed foreman of machine shop, Oregon Short Line R. R., at Pocatello, Idaho. Mr. Chandler was recently in a similar capacity at Springfield, Mo., on the Frisco lines.

C. J. Stewart, master mechanic of the Central New England R. R., at Hartford, Conn., has been appointed master mechanic of the New York, New Haven & Hartford, R. R., with office at Waterbury.

Edwin Schenck, Jr., assistant master mechanic of the Pennsylvania Railroad, at Meadows, N. J., has been appointed assistant master mechanic at the Trenton shops, succeeding F. E. Marsh, promoted.

Joseph Quigley, general foreman of the Chattanooga shop of the Cincinnati, New Orleans and Texas Pacific Ry., has been promoted to be master mechanic of the Alabama Great Southern R. R. at Birmingham, Ala.

H. B. Hayes, general foreman of the Danville, Ky., shop of the Cincinnati, New Orleans and Texas Pacific Ry., has been transferred to the Chattanooga shop of that road, succeeding Joseph Quigley, promoted.

Oscar Kuenzel, formerly an editor on this Journal, has been appointed assistant engineer of tests of the Santa Fe, with headquarters at Topeka, Kansas.

G. W. Lillie has been made an assistant superintendent of the Idaho division of the Oregon Short Line R. R. at Pocatello, Idaho, in charge of mechanical matters, including the supervision of the Pocatello shops and roundhouse.

Geo. A. Holden, formerly roundhouse foreman on the Michigan Central R. R. at Michigan City, Ind., has been promoted to general foreman of the locomotive department, with office at Grayling, Mich., succeeding E. A. Keeler, transferred.

H. C. May, master mechanic of the Louisville & Nashville R. R., at South Louisville, Ky., has been appointed superintendent of motive power of the Chicago, Indianapolis & Louisville, with office at Lafayette, Ind., succeeding O. S. Jackson.

Wm. Garstang, superintendent of motive power of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Indianapolis, Ind., has been appointed also superintendent of motive power of the Cincinnati Northern R. R., with office at Indianapolis.

Frederick B. Childs, master mechanic on the Northern Pacific Ry., recently died suddenly of apoplexy, being stricken while on an inspection trip to Spokane, Wash. He was 46 years of age and was formerly in the employ of the Great Northern Ry.

G. M. Gray, mechanical engineer of the Bessemer & Lake Erie R. R., at Greenville, Pa., has been appointed superintendent of motive power; with office at Greenville, succeeding E. B. Gilbert, who has been appointed special agent of the motive power department.

C. T. Boynton has been promoted from night foreman at Avon, N. Y., shops, Erie R. R., to be general foreman at the same terminal. Mr. Boynton succeeds H. Clay, who has been transferred to the Erie shops at Dunmore, Pa., as machine shop foreman.

R. G. Smock, secretary of the St. Paul and Des Moines R. R., with office at Des Moines, Ia., will hereafter have charge of the purchase of all materials and supplies. This is incidental to the resignation of W. J. Souder as auditor and purchasing agent of that railroad.

George Hunter, former master mechanic at Palestine, Tex., for the International & Great Northern R. R., and for the past few years master mechanic for the Kansas City Southern at Pittsburg, Kan., has been made master mechanic of the Missouri Pacific Ry. at Jefferson City, Mo.

Willard Kells, master mechanic of the Lehigh Valley R. R. at Buffalo, N. Y., has resigned. Mr. Kells will go to the Atlantic Coast Line as assistant general superintendent of motive power with headquarters at Wilmington, N. C. Mr. Kells has been in the service of the Lehigh Valley for the last ten years.

A. P. Prendergast, master mechanic of the Baltimore & Ohio R. R. at the Mount Clare shops, Baltimore, Md., has been appointed superintendent of motive power of the Baltimore & Ohio Southwestern R. R., with office at Cincinnati, Ohio, succeeding John Hair, resigned. This appointment became effective Nov. 16.

Robert Potts, who until his retirement from active service seven years ago was master car builder of the Michigan Central R. R. at St. Thomas, Ont., in which capacity he served for nearly 25 years, died recently, aged 71 years. Since leaving the car department he had been general inspector of the Buffalo-Detroit division.

W. H. Hamilton, division master mechanic at Argentine, Kan., on the Atchison, Topeka & Santa Fe Ry., has been transferred to Chanute, Kan., succeeding A. Mitchell, retired. E. E. Machovec, division master mechanic at Newton, Kan., succeeds Mr. Hamilton, and James McDonough, general foreman at Emporia, Kan., succeeds Mr. Machovec.

C. M. Hoffman, assistant superintendent of the Oregon Short Line R. R. and the Southern Pacific Lines east of Sparks at Pocatello, Idaho, in charge of mechanical matters, has been appointed superintendent of motive power of the St. Louis, Brownsville & Mexico Ry., with office at Kingsville, Tex., succeeding John Nicholson, resigned.

A. Dinan, division master mechanic of the Atchison, Topeka & Santa Fe Ry., at St. Madison, Iowa, has been appointed mechanical superintendent of the southern district of the western lines, with office at Amarillo, Tex. He will have jurisdiction over the Pan Handle division and territory from Clovis, Tex., to Belen, but not including shops or roundhouse at Belen.

M. J. Drury, mechanical superintendent of the northern district of the Atchison, Topeka & Santa Fe Ry., at La Junta, Col., has now jurisdiction over the Albuquerque shops and roundhouse, which have been transferred from the coast lines to the northern district. The latter now includes the Western, Arkansas River, Colorado, New Mexico and Rio Grande divisions.

L. R. Laizure has been promoted from general foreman of the Susquehanna shops, Erie Railroad, to be master mechanic of the Cleveland shop, including the Mahoning division. Mr. Laizure has had a varied experience on the Erie R. R. as inspector for new equipment and general foreman at the large shops, Hornell and Susquehanna, respectively. He succeeds H. B. Brown, resigned.

H. B. Brown, for several years master mechanic of the Mahoning Division of the Erie R. R. at Cleveland, O., has resigned to enter the service of the Illinois Central R. R. at Memphis, Tenn., in a similar capacity. Before accepting employment with the Erie Mr. Brown's previous experience had been altogether with the Baltimore and Ohio R. R. as machinist, engineer, road foreman of engines and master mechanic.

J. E. Muhlfeld, formerly general superintendent of motive power of the Baltimore and Ohio R. R., and since leaving that road engaged in special mechanical expert work for several roads, has been appointed vice-president and general manager of the Kansas City Southern Ry., with headquarters in Kansas City. He succeeds William Coughlin, who had the title of general manager and recently resigned. Mr. Muhlfeld will be in charge of transportation, maintenance of way and equipment, and the engineering and purchasing departments.

William C. Ennis, for many years master mechanic of the old New Jersey Midland Railroad, and its successor, the New York, Susquehanna and Western R. R., died at has home in Paterson, N. J., on October 30, in his 66th year. Mr. Ennis at one time held the position of master mechanic on the Central New England R. R. and Delaware and Hudson R. R., in addition to serving the American Locomotive Company in various capacities. He was a member of the New York Railroad Club, and an associate member of the American Railway Master Mechanics' Association.

W. H. Dooley, master mechanic of the Alabama Great Southern R. R. at Birmingham, Ala., has been appointed superintendent of motive power of that company and the Cincinnati, New Orleans & Texas Pacific, with office at Ludlow, Ky., succeeding J. P. McCuen, retired on account of ill health. Mr. Dooley was formerly a resident of Paterson, N. J., and learned the machinist's trade in the old Grant and the Rogers Locomotive Works of that city. Before going South about ten years ago he was with the Erie R. R. at the Bergen junction ships.

Charles E. Randall, railroad representative of Manning, Maxwell and Moore, died suddenly in Buffalo, N. Y., on October 22. Mr. Randall was sixty-nine years old. He had attained a wide acquaintance with railroad officials throughout the country, and his modest and unassuming demeanor with his readiness to oblige at any and all times had made them to a man his appreciative friends. On account of the death of his father he was obliged to go to work at the age of fourteen, at which time he became an apprentice in the Taunton Locomotive Works. At twenty-five he was chief engineer on a steamboat. A few years later he went with the Hartford Steam Boiler Works, in East Boston, where he was employed until 1879. On June 1, 1881, he entered the employ of the Hancock Inspirator Company as mechanical engineer and salesman, and has been connected with them since that time. When Manning, Maxwell & Moore, Inc., purchased the Hancock Inspirator in 1900, Mr. Randall then became associated with that company and has represented its allied industries, the Ashcroft Manufacturing Company, the Consolidated Safety Valve Company, the Hayden & Derby Manufacturing Company and the Hancock Inspirator Company. The funeral was held at Boston at 2 p. m. on October 25th.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Decorative Lighting Outfits.—The General Electric Company has just issued a folder, No. B-3011, describing its decorative lighting outfits for Christmas trees.

Feed Water Treatment.—The Dearborn Drug and Chemical Works, in a booklet entitled "The Treatment of Boiler Feed Waters," explains the Dearborn methods and gives much valuable information in connection with scale formation and boiler incrustation in general.

Bolt Cutters, Nut Tappers and Pipe Threaders.—Catalog No. 28, issued by Wells Brothers Co., Greenfield, Mass., describes and illustrates the complete line of the above Little Giant tools manufactured by the company and contains instructions for sharpening taps, dies and die bands, with several thread tables of value.

Metallized Filament Incandescent Lamps.—General Electric Co. bulletin 4780 describes and illustrates the Gem lamp, which has a higher economy and greater illuminating power than the carbon, although less efficient than either the tantalum or mazda. This bulletin supersedes all previous bulletins on the subject.

Graphite Products.—A new booklet has just been issued by the Joseph Dixon Crucible Co., of Jersey City, N. J., covering the Dixon line of products that are widely used in railroad service. The booklet runs to 40 pages, and is quite attractively illustrated by means of photographs showing different views of railroad stations and yards, different types of locomotives, stretches of track, signals, bridges, etc.

Thermit Rail Welding.—This interesting operation forms the title of a most complete catalogue by the Goldschmidt Thermit Co., 90 West St., New York. It is doubtful whether the subject could possibly be treated with more clearness in the same number of words than is exhibited in this book of 16 pages. It is finely illustrated from photographs which are directly to the point as explanatory of the text.

Hot Metal Working Machines.—The Ajax Manufacturing Co. has just issued a new catalogue which fully illustrates the various lines of the Ajax machines, together with the many products produced in them by the machine method. The catalogue devotes several pages to the illustration of photographic reproductions of the wide range of forgings which are possible through the use of forging machines. The book is also very complete in useful reference tables in connection with this work.

Cast Steel Valves and Fittings.—The Crane Co., of Chicago, Ill., in a special steel catalogue, presents the line of the above which they have been manufacturing for some time to meet the steadily growing demand for a superior grade of goods especially adapted for high pressure saturated and superheated steam lines and extreme hydraulic service. The catalogue contains 64 pages and illustrates the steel valves and fittings which are ordinarily considered standard, with a variety of useful information in connection therewith.

Draft Gear.—The T. H. Symington Co., manufacturers of the Farlow draft gear, has issued a very attractive catalogue covering its features in detail which are associated with this arrangement. The book contains several excellent cuts of the assembled gear and the various component parts. Two of its illustrations in particular are of much interest in demonstrating the ease and rapidity with which the "coupler without a yoke" can be removed when contrasted with the yoke coupler.

Cutter Grinders.—This is the title of a catalog issued by the R. K. Le Blond Machine Tool Co., of Cincinnati, O., which through the completeness of presentation becomes a treatise on the subject. The book is handsomely illustrated with many most interesting photographic reproductions of the Universal Cutter and Tool Grinder at work on actual operations. The machine is shown at work on a wide range of subjects, including milling cutter teeth, cut-off saw, reamers, drills and mandrels. The catalog contains 70 pages and carries a great amount of useful information on this subject.

Unit Switch Control.—The new Westinghouse hand operated switch control is attracting much interest and favorable comment among railway men. The company made this control an attractive feature in its exhibit at the Atlantic City Convention and has just issued a very complete circular, No. 1189, descriptive of the system. Recent orders placed with the Westinghouse Co. for this HL control include equipments for the following roads: Ohio Electric Company, Illinois Traction Company, Peoria Railway & Terminal Company, Winona Interurban Railway Company, Indiana Union Traction Company, Alton, Jacksonville & Peoria Ry.

Articulated Compound Locomotive.—Bulletin No. 1006, issued by the American Locomotive Co., entitled "Manual of the American Articulated Compound Locomotive," clearly describes and illustrates this type of construction which has attained a considerable vogue in this country. Considerable space in the bulletin is devoted to a description of the intercepting valve and its operation, and to the power reversing gear and by-pass valves. The bulletin is accompanied by a most elaborate inset drawing, covering the various positions of the intercepting valve under different conditions, which is a work of art in itself.

Electrification of the Cascade Tunnel.—The General Electric Co. has recently issued a very attractive bulletin illustrating and describing the electrical equipment of the Great Northern Railway in the Cascade Tunnel Division. The section electrified is part of the main line, including the tunnel through the Cascade Mountains. The difficulties encountered before electrification and the manner in which they were overcome are told in Bulletin No. 4755. As similar conditions exist on other trunk lines, this pamphlet will be of interest to show the ability of electric traction to handle traffic satisfactorily on sections of other railroads where, owing to certain physical conditions, operation of the steam locomotive is undesirable.

WATTHOUR METERS.—A very instructive pamphlet on the principles of construction and operation of watthour meters has just been issued by the Westinghouse Electric and Manufacturing Company. Though in the form of a descriptive circular, the pamphlet goes at some length into the question of rates and the theory of meters, and points out the importance of the various features and adjustments of modern meters, both A. C. and D. C. Even to one reasonably familiar with the subject, the pages on "Selection of Watthour Meters" will bring out valuable points often lost sight of. The circular is well worth the attention of those interested in meter operation. Its title is Circular 1137.

LOCOMOTIVES FOR PASSENGER SERVICE.—Record No. 67, issued by the Baldwin Locomotive Works, Philadelphia, Pa., illustrates and describes fourteen locomotives recently built by that company for passenger work. The designs shown include several wheel arrangements and cover a wide range in weight and capacity. For high speed work where sufficient adhesion can be secured in a locomotive with two pairs of driving wheels the Atlantic type appears to be favored because of its large steaming capacity. The Record indicates that where the trains are so heavy that three pairs of driving wheels are required, the Pacific type is generally employed. The Record maintains its usual attractive appearance and typographical excellence.

NOTES

SAFETY CAR HEATING AND LIGHTING CO.—This firm announces that its office for the southeastern district, at Washington, D. C., has been removed from the Home Life Building to 506 Munsey Building.

BURTON W. MUDGE & CO.—This company, which manufactures the Garland car ventilation devices, has appointed J. L. Phillips manager of its electric railway department. Car ventilation is a very live subject with electric railways, and Mudge & Co. have recognized this fact by organizing a department devoted to that particular line.

GISHOLT MACHINE CO. AND JOSEPH T. RYERSON & SON.—In connection with the association of interests which has been formed between these two companies, it is further announced that coincident with the new relationship, Edward T. Ryerson and Clyde M. Carr, of Joseph T. Ryerson & Son, become directors of the Gisholt Machine Co.

EDGAR ALLEN AMERICAN MANGANESE STEEL CO.—Walter Brinton, superintendent of the manganese steel department of the Taylor Iron and Steel Co. since 1895, has resigned to accept a position with the above company as consulting engineer. Mr. Brinton's headquarters will be at the Newcastle, Del., plant.

RELIANCE ENGINEERING AND EQUIPMENT CO.—F. G. Bolles, commercial engineer of the Allis-Chalmers Co., has resigned in order to devote his entire time to the above company at 1417-1419 Majestic Bldg., Milwaukee, Wis., in which he has an equal interest with C. A. Tupper and others. The company, which is taking on a number of additional exclusive agencies, will remove December 1 to 415, 416 and 417 Engineering Bldg., and will considerably extend the scope of its operations.

DUFF MANUFACTURING CO.—Announcement has been made by this company, of Pittsburgh, Pa., that it has acquired the business of William Forgie, Washington, Pa. The transaction implies the purchase of the entire Forgie plant, including its business and all rights and privileges of making the oil well jacks which were originated by William Forgie in the early days of the business. While the Duff company will continue to manufacture its own jacks, they will take up all of the original Forgie models and place them on the market.

JOHN I. ROGERS has opened a New York office in the City Investing Building at 165 Broadway, and will now use it as his Main Office. He is making a specialty of forging by the steam hammer, the drop hammer and the hydraulic press; of special rolling, such as railway tires and rolled wheels; of the use and manufacture of alloy steels; of machine shops and power plants and of general iron and steel works engineering. Mr. Rogers resigned from the Midvale Steel Company of Philadelphia about one year ago to take up professional practice and since that time has been engaged in consultation work and design along the above lines.

FALLS HOLLOW STAYBOLT COMPANY.—It is announced by this company that Thomas F. Meek, 415 Moffat Building, Detroit, Mich., has been appointed their representative for Southern Michigan, and the boiler trade in Toledo, O. Mr. Meek was secretary and manager of sales for the Detroit Steel Casting Company for twenty years. He has a wide circle of friends and his genial disposition and excellent reputation should combine to make him popular and successful in his new line of work. It is also announced that Frank R. Goehler has been appointed the Chicago railroad representative of this company, with office at 1143 Marquette Building, Chicago, Ill. Mr. Goehler was formerly connected for some four years with the purchasing department of the A. T. & S. F. Ry. Co. at Chicago, resigning to accept a position as Factory Business Manager with The Buda Company, at their works at Harvey, Ill. He is a young man of wide business acquaintance, with whom he enjoys a most excellent reputation.

FOR YOUR CARD INDEX

Some of the more important articles in this issue arranged for clipping and insertion in a card index. Extra copies of this page will be furnished to subscribers only for eight cents in stamps.

Boiler Washout System AMER. ENG., 1910, p. 469 (December).

Fully illustrated description of the National Boiler Washing Co.'s apparatus as applied in Corning enginehouse, N. Y. C. Lines.

Coaling Station at Corning, N. Y.

AMER. ENG., 1910, p. 463 (December).

Reinforced concrete structure of the Holman balanced bucket type, coaling on three tracks. Steam heated, electric lighted and altogether an excellent example of up-to-date construction and arrangement. Does not have weighing hoppers. Built by Roberts & Schaefer Co., Chicago.

Doors—Engine House AMER. ENG., 1910, p. 467 (December).

Photographs and drawings showing the construction of the Pitt balanced doors as used for enginehouses, example being at Corning, N. Y., on the N. Y. C.

Locomotive—2-6-6-2 Type, C. & O. Ry.

AMER. ENG., 1910, p. 471 (December).

Illustrated description of locomotives built by the American Locomotive Co. Very large boiler with 6 ft. 6 in. combustion chamber and 24 ft. tubes. Boiler is illustrated and described.

Locomotive Terminal AMER. ENG., 1910, p. 461 (December).

NEW YORK CENTRAL LINES AT CORNING, N. Y.

Complete and fully illustrated description of a terminal constructed from the standard plans of the N. Y. C. & H. R. R. Has a 30 stall enginehouse. Large and fully equipped power house. An excellent machine shop. Reinforced concrete coaling station, which is steam heated and electric lighted.

Machine Tools—Lathes AMER. ENG., 1910, p. 490 (December).

Illustrated description of recent engine and motor driven lathes designed and built by the American Tool Works Co., Cincinnati.

Machine Tools—Radial Drill

AMER. ENG., 1910, p. 488 (December).

Fully illustrated description of very powerful radial drill built by the Fosdick Machine Tool Co. of Cincinnati.

Machine Tools—Shaper AMER. ENG., 1910, p. 495 (December).

Illustrated description of a 26-inch triple geared shaper. Built by John Steptoe Shaper Co., Cincinnati.