(ESTABLISHED 1832.)

AMERICAN ENGINEER

CAR BUILDER AND RAILROAD JOURNAL.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. M. VAN ARSDALE, Proprietor.

Published Monthly at 140 Nassau Street, New York.

INDEX TO VOLUME LXX.—1896.

ILLUSTRATIONS.

NOTES AND NEWS.

EDITORIAL.

AMERICAN ENGINEER
CAR BUILDER AND RAILROAD JOURNAL.

JUNE, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

I.

The principal shops of the Pennsylvania Railroad for the repair and construction of cars and locomotives, as most of our readers know, are located at Altoona, and, as many of them are also aware, this place is a sort of mechanical Mecca to which many pilgramages are made, by those who are in pursuit of information or enlightenment on the many abstruse problems relating to the mechanical engineering of railroads. A visit to this place is therefore always interesting, and it is hoped that some notes and observations of a recent ramble, through the great works which are established there will be interesting and may be profitable to our readers.

For the following facts regarding the location of Altoona and its surroundings, we are indebted to an illustrated "historical descriptive and statistical" volume published by its Board of Trade.

"The city of Altoona was laid out in 1849 and the Pennsylvania Railroad commenced the construction of its shops in 1850. It is situated about thirty miles southwest of the geographical center of the great State of Pennsylvania, just at the eastern base of the Allegheny Mountains, near the headwaters of the Juniata River—the 'Blue Juniata' of Indian legend and pale-faced song, and on the line of the Pennsylvania Railroad. It lies in the upper or western end of Logan Valley or 'Tuckahoe,' as the vicinity was called in early days, in the central part of Logan township, in Blair County. By rail it is 117 miles east of Pittsburg and 235 west of Philadelphia, although an air line would be one-fourth to one-third less. Baltimore and Washington are 150 miles southeast and Buffalo 200 miles directly north, but by rail the distance to these points is nearly twice as great.

"Originally laid out in a narrow valley, it has filled this and climbed the hills on either side and grown in all directions, so that a large part of it is built on hills of moderate elevation. The city lines, as now established, embrace a territory two and one-fourth miles wide, but it is built up as a city a distance of four miles long and two miles wide. Less than 50 years old, it has grown with such surprising rapidity that it now contains a population of over 40,000 and is now the eighth city in the state in population, and second to none in material prosperity.

"The lowest ground in the city is 1,120 feet above the level of the ocean, and the hills rise 100 to 150 feet higher, making the site and surroundings picturesque in the extreme. . . .

"The railroad passes through the heart of the city from northeast to southwest. . . . In the central part of the city, on the lower ground, are located the railroad company's machine and locomotive shops, freight warehouse, passenger station and an immense hotel, around which the business of the city clusters, this being the 'hub'; although the ever-increasing business of the road has necessitated the building of additional shops at two other places in the eastern suburbs."

The "car shops" are located about a half mile east of the locomotive shops and the "Juniata shops," which have been built within a few years for the construction of locomotives, are about a mile east of the car shops.

Elsewhere plans showing the location of each of these three groups of shops are given, and also a view of the yard taken from the west end of it, adjoining the repair shop, and which shows part of one of the engine houses, and of other buildings, and the network of tracks at that point. Another view of the car shops and the grounds adjoining will give an excellent idea of the appearance of that locality and still another one of the "Juniata shops taken from the north looking southward shows their appearance and that of their environment. The plans represent the shops and grounds, as maps ordinarily do, that is the person looking at them is supposed to be on the south side. As visitors nearly always approach the shops from the north side and as the perspective view of the Juniata shops is taken from the north the plans may at first be a little confusing.

The main or "locomotive shops" as they are called, are the oldest and most extensive and are devoted chiefly to the repair of locomotives, although also some new construction work is done there. The following are the principal buildings and their dimensions:

Middle division round house	235 feet diameter
Erecting shop No. 1	413 feet by 66 feet
Machine shop (two stories)	352 " 63 "
Erecting shop No. 2	414 " 66 "
Office store room, laboratory and test room (three stories)	170 " 40 "
Boiler house	66 " 43 "
Flue shop	125 " 40 "
Boiler and blacksmith shop	192 feet diameter
Blacksmith shop	219 feet by 56 feet
Wheel shop	219 " 66 "
Boiler flange and tank shop	124 " 66 "
Wheel annealing pits	95 " 58 "
Pittsburg division round house	300 feet diameter
Iron foundry	245 feet by 96 feet
Wheel foundry	137 " 70 "
Core room, pattern shop on second floor	80 " 71 "
Brass foundry	78 " 55 "
Pattern store room (two stories)	98 " 48 "
Oil house	57 " 47 "
Wheel foundry	163 " 63 "
Total floor area	367,311 square feet

The car shops, as their name implies, are devoted chiefly to the construction and repair of cars, but a group of small buildings are devoted to work for the maintenance of way. The following are the principal buildings and their dimensions:

Passenger car paint shop	420 feet by 132 feet
Electric transfer table and pit	397 " " 60 "
Group of maintenance of way buildings	19,142 square feet
Freight car paint shop	392 feet by 108 feet
Freight car truck shop	82 " 70 "
Planing mill	356 " 74 "
Blacksmith shop	357 " 73 "
Machine and cabinet shop	303 " 73 "
Upholstering and trimming shop (two stories)	363 " 73 "
Passenger car erecting shop	213 " 133 "
Office and storeroom (two stories)	79 " 39 "
Freight car shop	433 feet diameter
Steam turntable	100 " "
Lumber drying kilns	3,343 square feet
Fire apparatus	53 feet by 33 feet
Total floor area	368,680 square feet

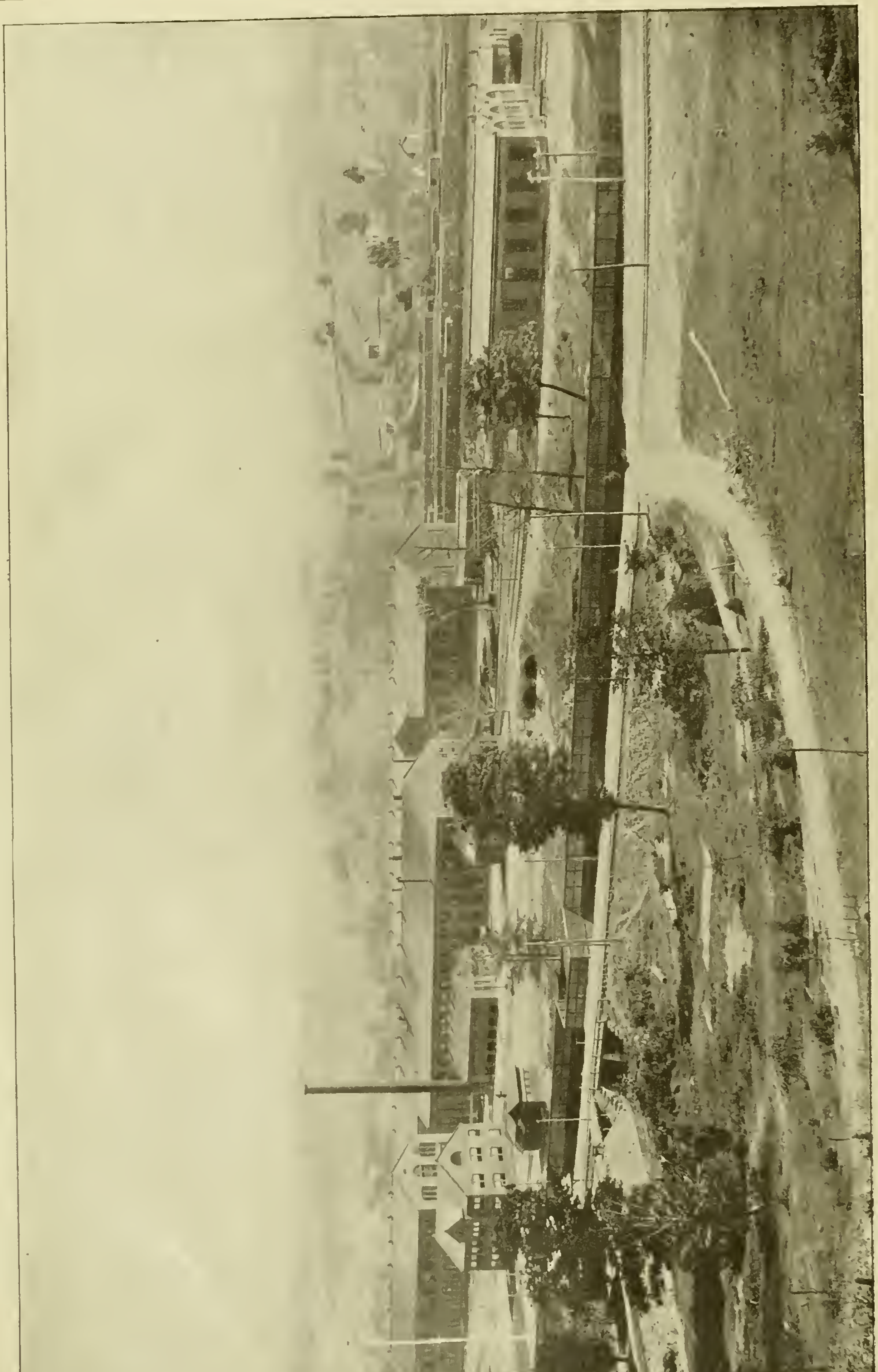
The Juniata shops are the newest and were built for the construction of new locomotives. A part of them are now devoted to the repair and construction of frogs and switches and other maintenance of way work. The shops are splendidly equipped with the latest and most approved machinery. The buildings are as follows:

Paint shop	116 feet by 67 feet
Electric and hydraulic house	60 " 45 "
Boiler shop	386 " 80 "
Blacksmith shop	306 " 80 "
Boiler house	70 " 43 "
Office and storeroom (two stores)	71 " 51 "
Hydraulic transfer table and pit	261 " 60 "
Erecting shop	351 " 70 "
Machine shop (two stories)	258 " 75 "
Total floor area	118,986 square feet.

The entire area of the floors of all the shops is 854,980 square feet or 19.7 acres.

It would be very difficult to give a systematic account of all of these shops, and the many interesting processes and appliances which are carried on in them. Only a large book or many chapters would suffice for that purpose. No attempt will therefore be made to arrange our observations in any systematic order, but they will be noted as they were brought to the attention of the writer during a "personally conducted" ramble through these great establishments. Before doing this it will be explained that the engraving of two passenger locomotives on the double page illustration herewith represents the latest type or "Class L" engine built by this company, and also their "Class G" engine, which was built and was the standard type in 1873. The illustration and the following dimensions give a good idea of the increase in size of locomotives within the past twenty-two years.

	Class G.	Class L.
Diameter of driving wheels	56 inches	80 inches
Cylinders	15 by 22 inches	18½ by 26 inches
Weight	65,200 pounds	134,500 pounds
Pressure in boilers	125 pounds	185 pounds



JUNIATA SHOPS OF THE PENNSYLVANIA RAILROAD, ALTOONA, PA.

View of West End of Pennsylvania Yard, Altoona, Pa.

Car Shops of the Pennsvlvaria Railroad Altoona Pa.

We will have more to say about the "Class L" engine in a future article.

The Pennsylvania Railroad Company for many years past has made many of the cast-iron wheels used on its road. In connection with the locomotive shops is a well-equipped wheel foundry where large numbers of wheels are and have been made. Great pains have been taken and much skill exercised to procure the best possible materials for their manufacture, and to produce the strongest, safest and most durable wheels of that kind. Recently an expensive accident occurred on the road while a train was coming down the long and steep grade west of Altoona. The accident was caused by a broken wheel under a foreign car, the failure of which was attributed to the action of the brakeshoes, which were applied in descending the grade, and which heated the wheel, and it was thought thus cracked it. To throw some light on the subject, it was decided to make tests of wheels made by different manufacturers, to determine the effect of heating the tread. To do this the wheels were placed in a sand mould flatwise, with their flanges down and their axes vertical. Around the tread of the wheel a circumferential space was left 1½ inches wide measured radially to the wheel, this space being surrounded with sand, the top of the mould being left open. Into this space molten cast-iron was poured, with the result that in many cases some of the ribs or brackets were cracked in about half a minute after the metal was poured, and the plates in about a minute after the molten metal came in contact with the tread. At the time of the writer's visit to the foundry, which is here reported, three new wheels were prepared for such a test; two of them manufactured by a reputable maker, and one of these two wheels was taken from those supplied by the manufacturer in the regular course of trade, and the other a special wheel furnished for the test, and said by the maker to be the best he could produce. The third was a new wheel made in the Altoona foundry. In one of the tests the molten iron was poured into the space around the tread of the wheel first described, so as to nearly fill it up to the edge of the rim. In forty seconds after the pouring ceased there was a sharp click indicating that one of the brackets was cracked, and in forty-five seconds the upper plate cracked with a report like that of a small pistol. The crack was a radial one through the rim, and it then extended circumferentially just inside the rim about one-sixth of the way around the hub. The second wheel, which was said by the maker to be the best that he could produce, cracked in the same way in the plate in two minutes after the iron was poured, the fractures being of somewhat less extent than the first. The Altoona wheel was then tested, but did not break when the melted iron poured around it had become black by cooling. Other tests have been made of wheels which had been in service with similar results. The Altoona wheels are reported to have stood the test in every case excepting one, while a large proportion of those made by manufacturers who sell wheels were broken. During a considerable part of the time after the iron was poured, when the tests which are described above were made, the wheel was so cool that a person could bear his hand in the inside of the rim, and the plate, excepting the portion near to the rim, was so cool during the whole test that a person's hand could be kept in contact with it without pain. A match moved slowly in contact with the plate from the hub toward the rim immediately after the test was not lighted until it was near the rim.

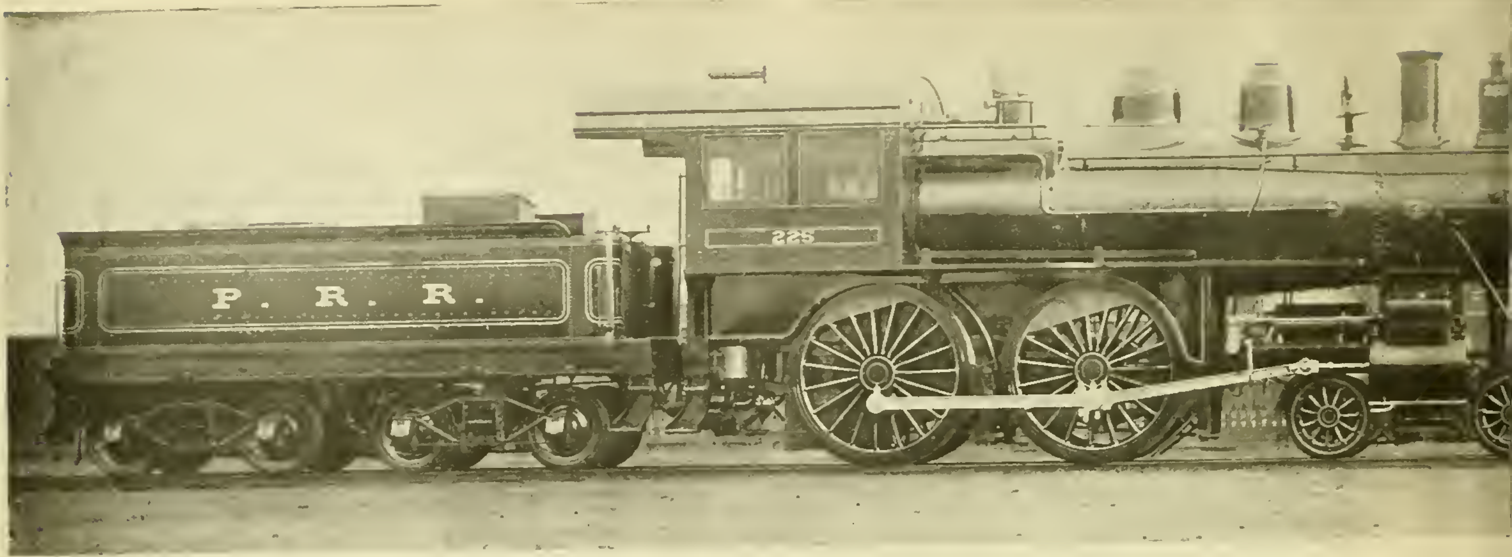
These tests are certainly very remarkable, important and somewhat alarming. If, as was shown, an ordinary cast-iron wheel is liable to break when its rim is heated to a comparatively low temperature, there is certainly very much more danger attending their use on long grades when the brakes must be applied for considerable periods than is generally supposed, and the responsibility for using cheap and inferior wheels is correspondingly great. The forms of the wheels which were tested were all alike and were of the ordinary double plate pattern, with curved ribs on the back, so that the capacity for withstanding the test in the one case and the failure in the other was probably due to the difference in quality of the material of which they were made. It may be that if the wheels made of inferior material had been of a different form they would not have broken, and this kind of tests supplies the means for determining what are the best forms for such wheels. Thus far those adopted appear to have been evolved by rule of thumb methods alone. It may be that the forms which have been used so long are weaker than was ever suspected, and that some other shapes would be much less liable to fracture. The test showed indubitably that heating the treads of the wheels subjected their plates and ribs to tremendous strains, and the only reason why the Altoona wheel did not break was that the material of which it was made had sufficient strength, elasticity, ductility, toughness, or whatever it is called, to resist these strains. It would seem to be the part of wisdom to make wheels, if it be possible, of a form which would not be subject to such strains when their treads are heated, as they were in the tests, or as they would be by the application of brakes. It would be interesting and possibly instructive to put wheels say in a lathe and apply brakes to them with the ordinary maximum pressure and then revolve the wheels at the speed with which they would probably turn in actual service. This would show whether the heating action of the brakeshoes has the same effect as the molten iron produces. This is an attractive field for investigation and one in which more knowledge is urgently needed.

The Altoona wheel foundry is well equipped with hydraulic cranes and other appliances. The wheels are now all made in contracting chill moulds which give a more uniform chill in the treads of the wheel than can be produced in any other way. The materials used for wheels are from 30 to 35 per cent. of charcoal iron, 15 per cent. of coke iron, 5 per cent. of steel and from 50 to 55 per cent. of old wheels. It is specified that the coke iron shall not have more than from 1 to 1.25 per cent. of silicon.

One machine in use in connection with the foundry was new to the writer. This was for brushing the sand from the wheels. It was made by the Northwestern Wheel and Foundry Company, of St. Paul, Minn., and consists of two iron discs of about the same diameter as the wheels, which are each mounted on the ends of horizontal shafts. Each disc overhangs the bearings of its shaft, which has a driving pulley and friction clutch for throwing in and out of gear. The discs face each other, and to the surfaces thus presented wire brushes are attached, and the wire strands project at right angles to the faces of the discs, the wires being parallel to the axis of the shafts. The latter have a certain amount of horizontal movement in their bearings, so that by means of levers the discs can be drawn apart and a wheel rolled between them. The discs are then made to revolve by belts on pulleys attached to the drafts, and the brushes are brought in contact with the two sides of the wheel, and all the sand is thus quickly brushed off from the exposed surfaces. That which adheres between the ribs is afterward brushed out by a cylindrical brush resembling somewhat a large paint brush attached to a flexible shaft driven by a pulley. The cost of cleaning wheels has been reduced three cents per wheel by the use of these machines.

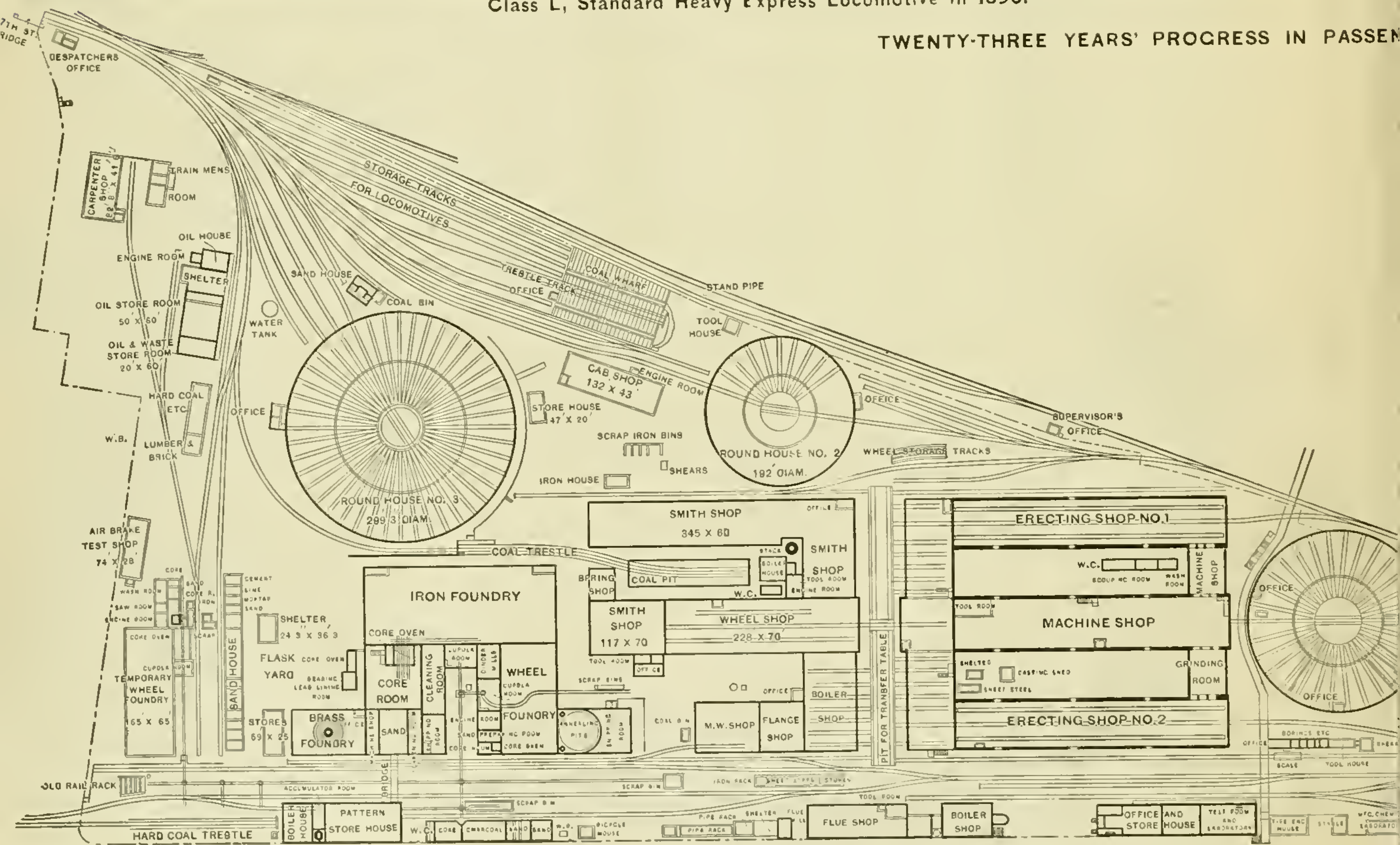
Another interesting machine is a sand sifter made by the Walker Manufacturing Company, of Cleveland, O. This consists of a rectangular box, about 3 by 5 ft. and a foot or 18 inches high or deep, and with a sieve forming the bottom. This box is suspended by inclined, loose-jointed links or rods about 2 feet long attached at each of the four corners. Over the middle of the box is a bearing which receives the pin of a crank attached to a vertical shaft over it and driven by a pulley or belt. As the crank revolves the bearing is of course carried in the path of its pin and the box is carried with it. The latter being suspended by the inclined links the horizontal oscillation of the lower ends of the latter causes the corners of the box to rise and fall in sequence, as it were, which with, the movement imparted by the crank, produces a sort of squirming or wriggling movement admirably adapted for sifting the sand which is put into the box.

The brass foundry is also an interesting place and is well arranged and designed. The building is 36 by 80 feet, with a central stack, or chimney, and with 18 furnaces arranged circularly around it. This building is admirably lighted and well ventilated, and has capacity for melting ten tons of metal per day. An adjoining room contains appliances for lining car journal bearings with lead. The bearing surfaces of these are first cleaned with

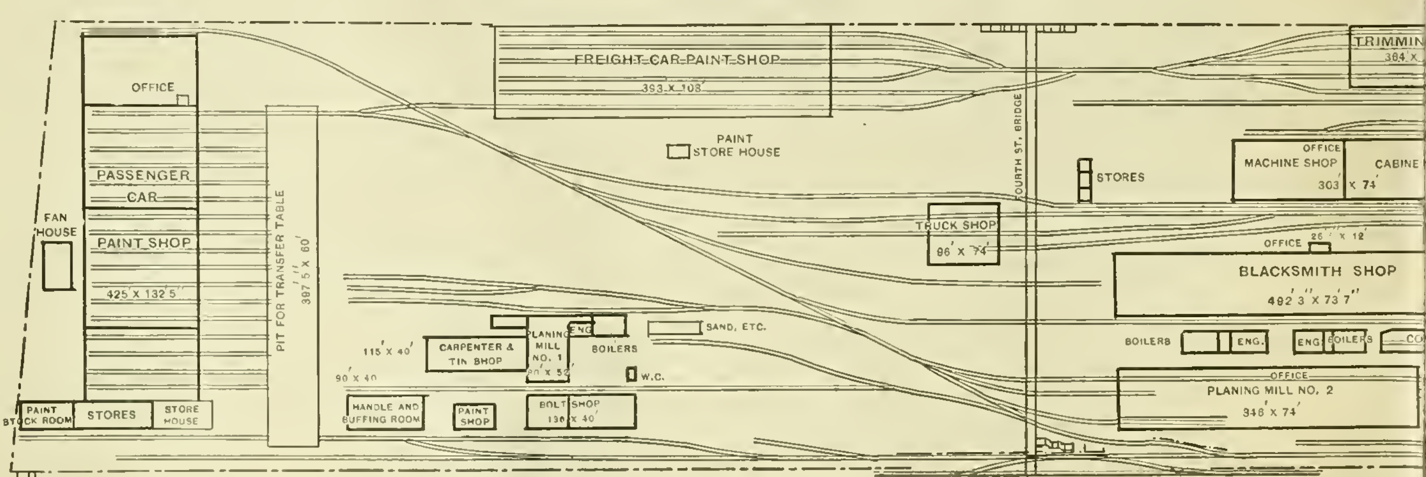


Class L, Standard Heavy Express Locomotive in 1896.

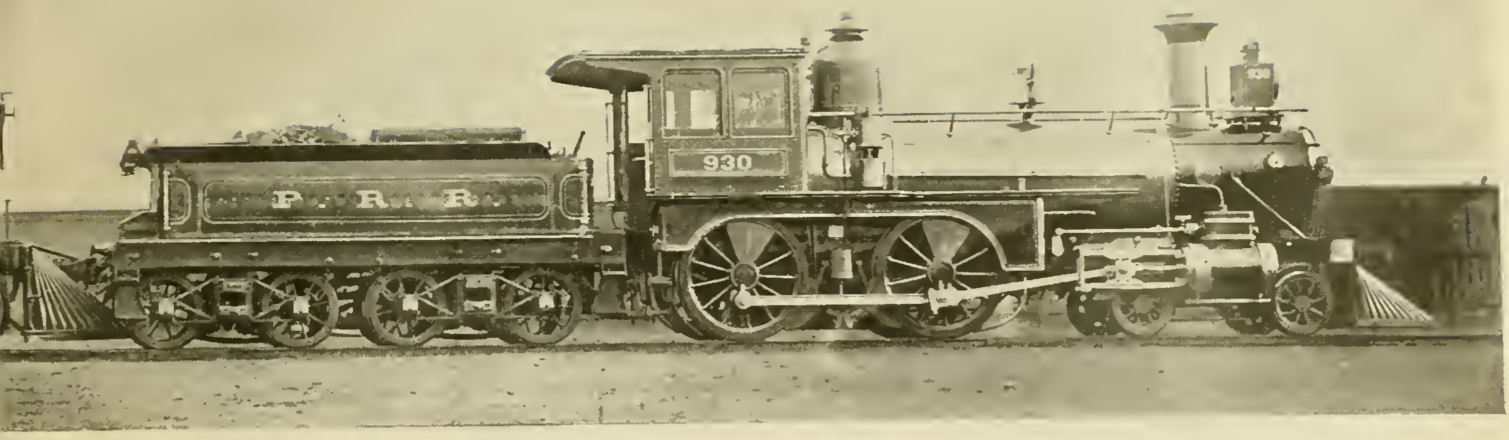
TWENTY-THREE YEARS' PROGRESS IN PASSEN



PLAN OF LOCOMOTIVE REPAIR SHOPS, ALTOONA, PA.

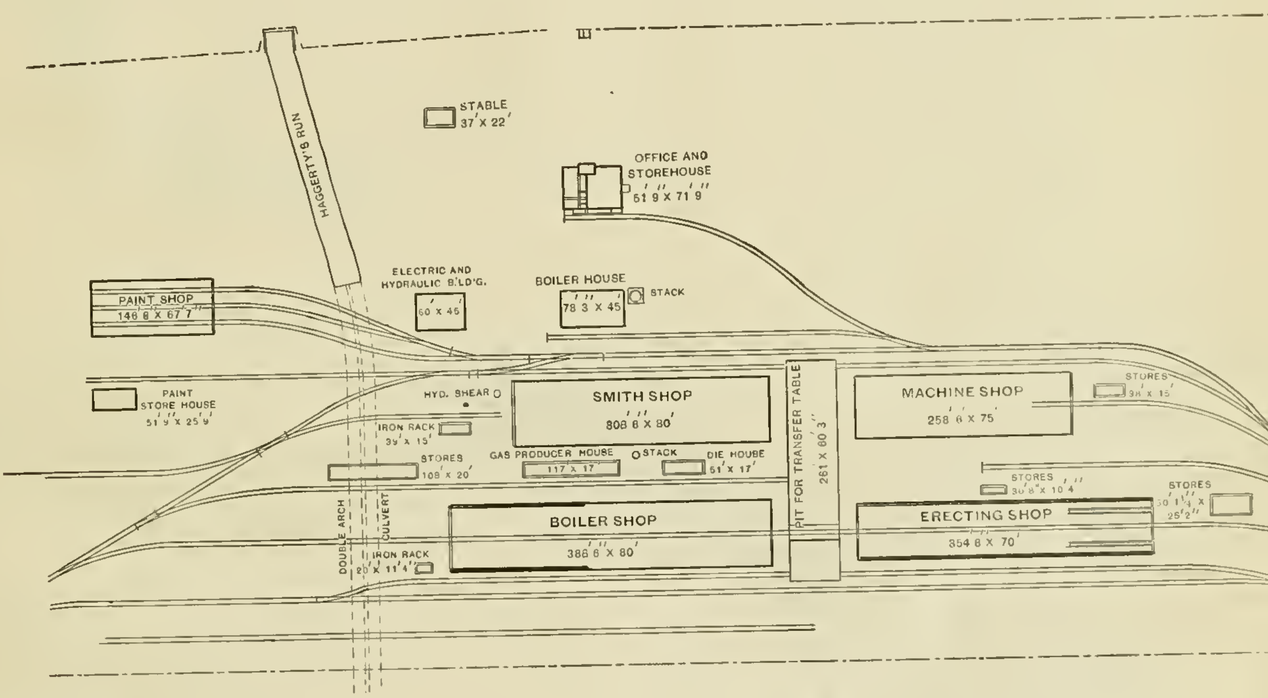


PLAN OF CAR SHOPS OF THE PE

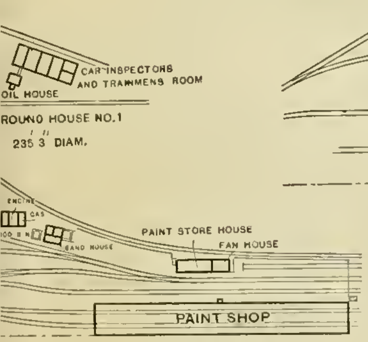


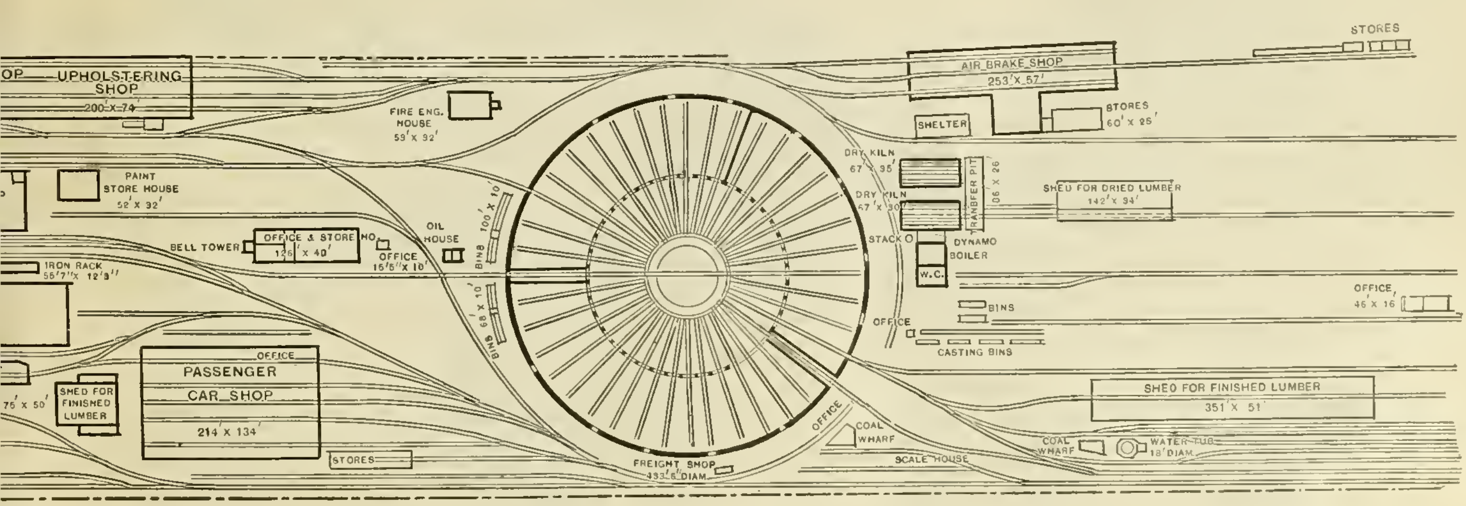
Class G, Standard Passenger Locomotive in 1873.

R ENGINE CONSTRUCTION ON THE PENNSYLVANIA RAILROAD.

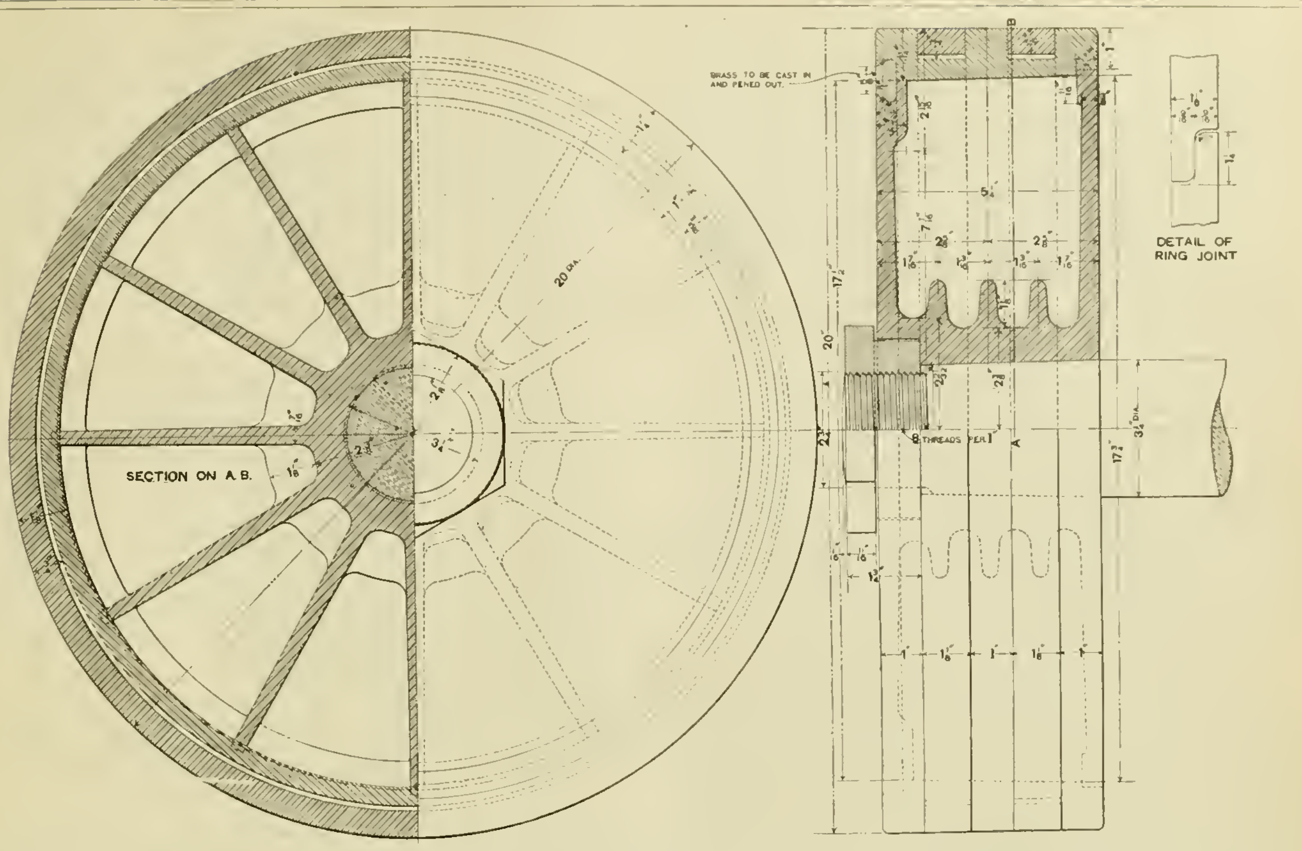


PLAN OF JUNIATA SHOPS, ALTOONA, PA.





SYLVANIA RAILROAD, ALTOONA, PA.



Malleable Iron Piston—Norfolk & Western Railroad.

dilute acid, and are then tinned. After this operation they are clamped against a vertical cylindrical iron "core"—it may be called—having projections which leave a space of about one-eighth of an inch between it and the brass into which the melted lead is poured. As soon as the lead is set the fin, or superfluous metal, which projects is cut off by a kind of shear attached to the core. The whole process is quickly done. This lead lining is generally used on bearings for the Pennsylvania road.

In the use of brass bearings it was found that what may be called hard nodules were formed in the metal, which were not worn away with the other metal, but would often project from the surface and wear into and cut the journals. The formation of these nodules was finally attributed to oxidation on the surface of the melted brass while it was in the crucibles. A cure for the evil was found in sprinkling powdered charcoal over the surface of the molten metal while it is in the furnace.

An interesting annex to the foundry is the boiler room. In this three large Bellpaire boilers of the locomotive type have been installed, with room for an additional one. The level of the engine-room is about five feet below a track which extends into it and is supported on posts or trestle work. The track runs transversely to the boilers and is about eight or ten feet back of them—speaking in locomotive parlance. The coal is brought in on drop bottom cars and dumped on this trestle. It is then within convenient distance for firing the boilers, and is placed in that position without any other labor than that of running the cars in and dumping them. In front of the fireboxes of the boilers is a transverse pit, or what might be called a ditch, which has a bucket, which runs on a track on the bottom of the pit. This bucket can be placed in front of the ashpan of any of the boilers and the ashes can be raked directly into it. Between two of the boilers is a lift which consists of an inclined runway extending from the ashpit backward over the track on which the coal is brought in. This runway has a wire rope operated by a horizontal cylinder and pulley under the roof. To remove the ashes, a car is run in on the track to receive them, and the bucket is then filled and brought to the foot of the runway, the wire rope is attached to it, water is admitted to the cylinder; the bucket, which has a drop-bottom, is carried up and over the car, when it is dumped and the ashes deposited in it without any other labor than is here described. The hydraulic cylinder and piston is operated by a pump and accumulator in the usual way. Adjoining the boiler room there is also a Clayton air compressor which supplies air to various appliances inside and outside the foundry. One of them is an air lift or hoist for loading and unloading cars. This consists of two posts about twenty feet high and placed about thirty feet apart with a transverse beam on top, to which a vertical cylinder with about ten-feet stroke and perhaps twelve inches diameter. The piston rod can readily be attached to any object which is thus raised by the admission of air to the cylinder.

A steel rail breaker is also an appendage to the foundry. This consists of a large hydraulic cylinder, somewhat like those used for hydraulic riveting machines, the piston of which works horizontally. The rail is placed between the ram and suitable bearings, and when water pressure is admitted the rail is broken almost like a pipe stem. The rails are reduced to short pieces to facilitate putting them in the cupola when they are mixed with the iron for the manufacture of wheels.

(To be Continued.)

Malleable Iron Locomotive Piston.—Norfolk & Western Railroad.

The Norfolk & Western Railroad has recently put into service a number of locomotive pistons, in which the head is of malleable iron, with an outer rim of cast iron. Through the courtesy of Mr. R. H. Soule, Superintendent of motive power, we have received the working drawings from which the accompanying engravings were made.

The head proper consists of a single casting of malleable iron, having a central hub $4\frac{3}{4}$ inches in diameter, and front and back plates or walls ranging from $\frac{3}{8}$ to $\frac{15}{32}$ inches thick. Twelve radial ribs, from $\frac{5}{16}$ to $\frac{7}{16}$ inches thick, extend from the hub outward and three circular ribs strengthen the hub. The casting resembles the ordinary "solid" piston except that it is open at the rim. This opening is closed by a cast-iron ring $1\frac{1}{4}$ inches thick, and the full width of the piston head, namely, $5\frac{1}{4}$ inches. The fit for this ring is made slightly conical, being, on this 20-inch piston, 17½ inches at the front face and 17⅞ inches at the front of the back wall, at which point there is a shoulder, and the diameter is enlarged to 18 inches. The ring is put on from the front and forced against this shoulder: it is then held in place by casting a brass ring into the dovetail groove in the front face of the piston. The brass ring is hammered down until it fills the groove tightly. The packing rings are cast-iron spring rings, 1⅛ inches wide and ⅝ inch deep.

The advantage of this construction lies in the fact that a light-weight piston is obtained, and yet cast iron, with its unexcelled wearing qualities, is retained for the surface in contact with the bore of the cylinder. The retaining ring for fastening the rim is a neat way of avoiding the use of bolts or rivets. The actual saving in weight over a cast-iron piston is shown in the following figures:

Type of piston.	Weight without packing rings.	Weight with packing rings.
Standard (cast-iron box)	257.5 pounds	280 pounds.
Composite	187.5 "	210 "

This shows a saving of 70 pounds if the composite piston is compared with the company's old standard piston. The officials believe that a further reduction of from 10 to 20 pounds can be effected in this design.

New York Central Locomotive No. 923.

A new anthracite coal burning locomotive has just been completed at the West Albany shops of the New York Central Company and has been put into service on the Hudson River division of the road. It is of the American type with 78-inch wheels and 18½ by 22-inch cylinders. The firebox is 108 inches long, and is placed on top of the frames and has a water-bar grate, which inclines downward toward the front. The springs and equalizing levers are below the driving-boxes, the latter being made of Ajax metal. The crown sheet is slightly arched and is supported with crown bars with a wagon top over them. The firebox rests on expansion links pivotally connected to the frames and to the boiler.

The general design and finish of the engine is similar to the celebrated 999. Nearly all the parts which were susceptible of it are brightly finished and polished, the fixtures in the cab being nickel-plated. Many of the bolt heads, as in the guide bars, smokebox and boiler braces are counter-sunk so as to make a smooth finish. The oil cups on the guide-bars are forged solid with them with tight fitting covers. The cylinder oilers have a self-measuring attachment by which a definite quantity of oil can be applied at each oiling.

The firebox has Mr. Buchanan's furnace door with an inside deflector, which has worked so satisfactorily on this road. As the trailing driving-axle is under the firebox, the ash-pan must be arched over it. It consists of two deep, hopper-shaped receptacles, one in front and the other behind the rear axle, and have sliding doors at the bottom which are operated by a vertical shaft, which extends upward through the foot-plate, and has a lever on its top end. When the doors are opened this must be turned outward and projects over the foot-plate behind the firebox, and is thus in the way of the fireman. When the doors are closed the lever is moved forward and then stands transversely to the engine, close to the firebox, and is then out of the way. The projection of the lever over the foot-plate is thus a reminder to the fireman that the doors are open, the object being to have them always closed when the engine is on the road. An opening is provided in the front of the ash-pan at some distance above the rails for the admission of air.

The tank is provided with a gage on the front end. This consists of a vertical iron pipe connected to the bottom of the tank, and with a cock in the connection. A number of small holes are drilled at close intervals along the whole length of the iron pipe. When the cock is opened water flows out of these holes, and thus shows how high the water is in the tank. The iron pipe has the advantage over a glass gage, that there is no danger of breaking it.

The apron which covers the interval between the foot-plate and tender is covered with sole leather, fastened with rivets, which gives a secure foothold for the fireman.

The driving truck and tender wheels all have cast-iron centers and steel tires fastened with retaining rings.

Another feature which has been very extensively adopted on new engines for this road is the extended piston rods. These project through the front cylinder-head, and are then supported by a guide and inclosed by a casing outside. It is reported that this device lessens the wear of piston packing and cylinders to a very great extent.

The connecting and coupling rods are fluted, the latter have solid bushed ends and the former stub ends, front and back, the straps being fastened with three bolts.

The hand-rails and hand-holds are covered with Russia iron, which is a new device.

The engine is equipped with monitor injectors, chime whistle and Gould's automatic couplers, at the front of the engine and back of tender. The engine and tender are both painted black, with silver striping. Excepting in some of the switching engines, we believe this is the first instance of the use of anthracite coal on the New York Central road. This one is intended for service on the trains between New York and Poughkeepsie.

The finish of the engine surpasses—if that is possible—that of the 999, and is an example of the best and most recent practice in American locomotive engineering.

Admission of Apprentices and Mechanics to the Engineering Courses of Purdue University.

In response to numerous inquiries in regard to the admission of experienced mechanics to the Engineering Courses, the President of Purdue University has published a statement embodying the practice of the University in such cases.

The courses in Mechanical, Civil and Electrical Engineering include lines of work such as carpentry, pattern-making, molding and casting, forging and machine work, with which shop men are often familiar, and for this reason such men may enter these courses under conditions which are greatly in their favor. Thus those who, as apprentices, have acquired skill in manipulation and have become acquainted with the principles of construction, can properly be excused from the shop work which other students are required to take; the experiences of the shop can in this way be made to count in advancing the student in his professional course. Or if it happens that an applicant is unprepared in some line of work required for admission, such deficiency need not prevent his admission, provided his credits in shop work are sufficient to give him time in which to bring up the required preparatory work.

Each application for credit or for conditional admission will necessarily require individual consideration, and persons seeking such admission are advised to inform themselves by correspondence before going to the expense of applying in person. The important conditions, however, governing the admission of persons having credits and conditions are indicated in the following statements:

1. Each applicant for admission who desires credits in shop work must present a statement in his own handwriting setting forth his shop experience, which statement should be indorsed and approved by the superintendent of the shop or shops in which he has worked.

2. Three years' experience as a regular apprentice or as a journeyman in an approved shop will be accepted as a complete equivalent for all shop work required by the college course. It is equivalent to a credit of nine hours per week for two years. An experience of less than three years may be accepted as an equivalent for a portion of the shop work required in the course.

3. Applicants for admission who can show that they are entitled to credits in shop work, but who are unable to pass entrance examinations, will be admitted conditionally if their general attainments indicate that they are likely to become successful students; but such applicants should not be less than twenty years of age.

4. Students admitted as freshmen, with credits in one or more lines of college work and with conditions in preparatory subjects, will be given regular instruction in the subjects in which they are deficient.

5. Students admitted with conditions will be required to pursue such lines of study in some one of the three courses named as will tend to make them regular. Special courses of selected studies will not be granted.

The Pennsylvania Avenue Subway and Tunnel in the City of Philadelphia.

The abolishment of grade crossings in large cities presents to the engineer many complicated problems for solution and involves the expenditure of millions of dollars. In some cases easy grades on the streets and the railroads, the minimum damage to adjacent property, economy in expenditure and a non-interruption of traffic are the chief problems, and even then the work is not an easy task. But when the railroad tracks whose grades are to be altered are connected by sidings to numerous manufacturing and industrial establishments, warehouses and elevators, and as a result of the improvements are found to interfere with existing water, gas and sewerage systems, the difficulties are vastly increased. Such is the situation which the engineers in charge have had to meet in preparing the plans for the new subway and tunnel for the Philadelphia & Reading Railroad in the city of Philadelphia.

Several years ago the railroad company completed its handsome terminal station, and the elevated approach to it, by which a number of dangerous grade crossings were avoided. But leading from these terminal tracks is a line running at grade through Pennsylvania avenue and crossing many streets. On each side of it are large industrial establishments, some of them of world-wide reputation, and all doing a large business, such as Wm. Sellers & Company, Baldwin Locomotive Works, Bement, Miles & Company, Whitney & Sons, and others. The constant switching of cars made the location so dangerous that finally the city authorities and railroad company mutually agreed to lower the tracks, the cost of the work to be shared equally by the two corporations. Accordingly an ordinance was passed by the City Council in March, 1894, accepted by the railroad company, and the work of preparing the plans placed in charge of the city's engineering department. The estimated cost of the work is $6,000,000, and upon its completion seventeen grade crossings will be abolished and the entrances to Fairmount Park relieved of objectionable features.

These plans are now complete, and such changes as were necessary in the sewage system of the city have already been made. During the past month the city has been receiving bids from contractors, and the work will be given out at an early date and construction pushed rapidly. The tracks will be lowered on the average 25 feet below the surface of the streets, and the total length of the right of way, the grade of which is altered, is 10,000 feet, of which 2,912 feet is tunnel, 6,028 feet is open subway, and the remaining 1,060 feet is elevated structure. Besides the sidings leading to industrial establishments, there are two freight yards adjacent to the main tracks which must also be depressed, one between Thirteenth and Sixteenth streets and the other at Twentieth street, where an engine house, coaling station and turntable are also located. The open subway is wide enough for from four to six tracks, and the tunnel is to contain four tracks. It is evident, therefore, that the work is one of great magnitude.

On page 96 we have reproduced a perspective of the work as it will appear when finished, and on this view is designated the location of a number of important manufacturing plants, most of them well known to our readers. On page 97 is given a plan of the subway and tunnel, with sections of both, and Figures 3 and 4 on page 99 give additional sections that are of interest.

The plans provide for a very slight change of grade at Twelfth street, the railroad being carried over it as at present. Beginning at Twelfth street the tracks continue on a down grade of 2½ per cent. to a point just beyond Broad street, where the grade is eased off to .8 per cent., which continues for about one and one-half blocks, after which the tracks are practically level to the portal of the tunnel. At Thirteenth street the tracks will cross at about the present grade of the street, requiring the latter to be depressed considerably, but this is the only street whose grade is changed materially. From Thirteenth to Sixteenth streets the entire space between the north side of Callowhill street and the north side of Pennsylvania avenue is to be excavated to form a depressed freight yard for the railroad company. All streets from and including Broad street to Twenty-first street are to be carried over the subway on bridges. This portion of the work to the portal of the tunnel presents the greatest difficulties, because of the numerous sidings and the fact that the retaining walls will come so close to the building lines as to require the underpinning of many buildings and the reconstruction of their foundations. Fortunately it has been found possible to reach all sidings which must be kept open by means of temporary tracks that will be laid through Hamilton street east from Pennsylvania avenue, thus leaving the contractors comparatively free to carry on this section of the work.

The connection to Baldwin Locomotive Works, near Broad street, and the warehouse across the way, near Sixteenth street, are each to be made by a five per cent. grade. Near Sixteenth street several tracks cross over the subway on a bridge, thus allowing an engine to place cars on either side of the right of way. Between Seventeenth and Eighteenth streets another connection is made to the Baldwin Locomotive Works, the maximum grade being five per cent., as before. These grades are indicated in the profile of Fig. 2. Between Nineteenth and Twentieth streets a grain elevator is reached by a four per cent. grade, and west of Twenty-first street a five per cent. grade leads to the Knickerbocker Ice Company's building. Connection to Bement, Miles & Company is to be made on the lower level, and the company will have a lift on its own property. The necessity for such steep grades leading to sidings arises from the short blocks. It is evident that each of these inclines must rise from the subway to the surface in less than the length of a block, and, as the blocks average considerably less than 500 feet long, the grades must be heavy.

Between Sixteenth and Eighteenth streets the firms of Wm. Sellers & Company and A. Whitney & Sons each have track connections, and to reach these parties a hydraulic lift is to be placed on the south side of the subway. It is seen in the perspective view, partly raised, and is also designated in Fig. 2 close to the Eighteenth street bridge. This lift is to be an immense affair, 155 feet long, and capable of carrying a locomotive and three loaded cars, making a total load of 320 tons, to be raised 26 feet. The great length of the table, and the fact that the load may be concentrated at almost any point on it, make the construction of this lift a very neat problem. The specifications for it do not impose any restrictions on bidders other than those inherent in the problem, the engineers in charge wisely concluding that these in themselves were difficult enough.

A commercial coal conveyor is to be located near Fifteenth street, and a power house south of the tracks between Eighteenth and Nineteenth streets will furnish hydraulic and electric power and light at various points along the subway and tunnel.

The triangular yard between Twentieth street, Hamilton street and Pennsylvania avenue, now occupied by the railroad company, is to be excavated, and will contain an engine house, a small repair shop, a coaling station with conveyors for ashes and coal, a freight house with hydraulic lifts, a 65-foot turntable and a 50-ton electric traveling crane of 43 feet 10 inches span, serving two tracks and capable of unloading direct from the cars to a roadway on the street level. Altogether quite a large and interesting plant is installed in this depressed space.

The tunnel begins just west of the above-mentioned yard. It consists of a single span of 52 feet, with a rise of 8 feet 8 inches, and is to contain four tracks. The arch is of brick and the tunnel is one of the widest of its kind. Its length is 2,912 feet, and a considerable portion of it parallels the two-track Baltimore & Ohio Railroad tunnel. The western portals of the two tunnels are in close proximity. A section of the tunnel is given in Fig. 2, and Fig. 3 is a section through the two tunnels, showing their relation to each other and also giving an idea of the ventilating arrangement for the new tunnel. Owing to the heavy traffic contemplated and the large dimensions of the tunnels, an elaborate system of ventilation has been provided with exhaust fans and fresh air intakes. West of the tunnel the tracks will be carried in an open subway on an ascending grade of 1.3 per cent. to the present level of the track at Thirtieth street. Footway bridges will be

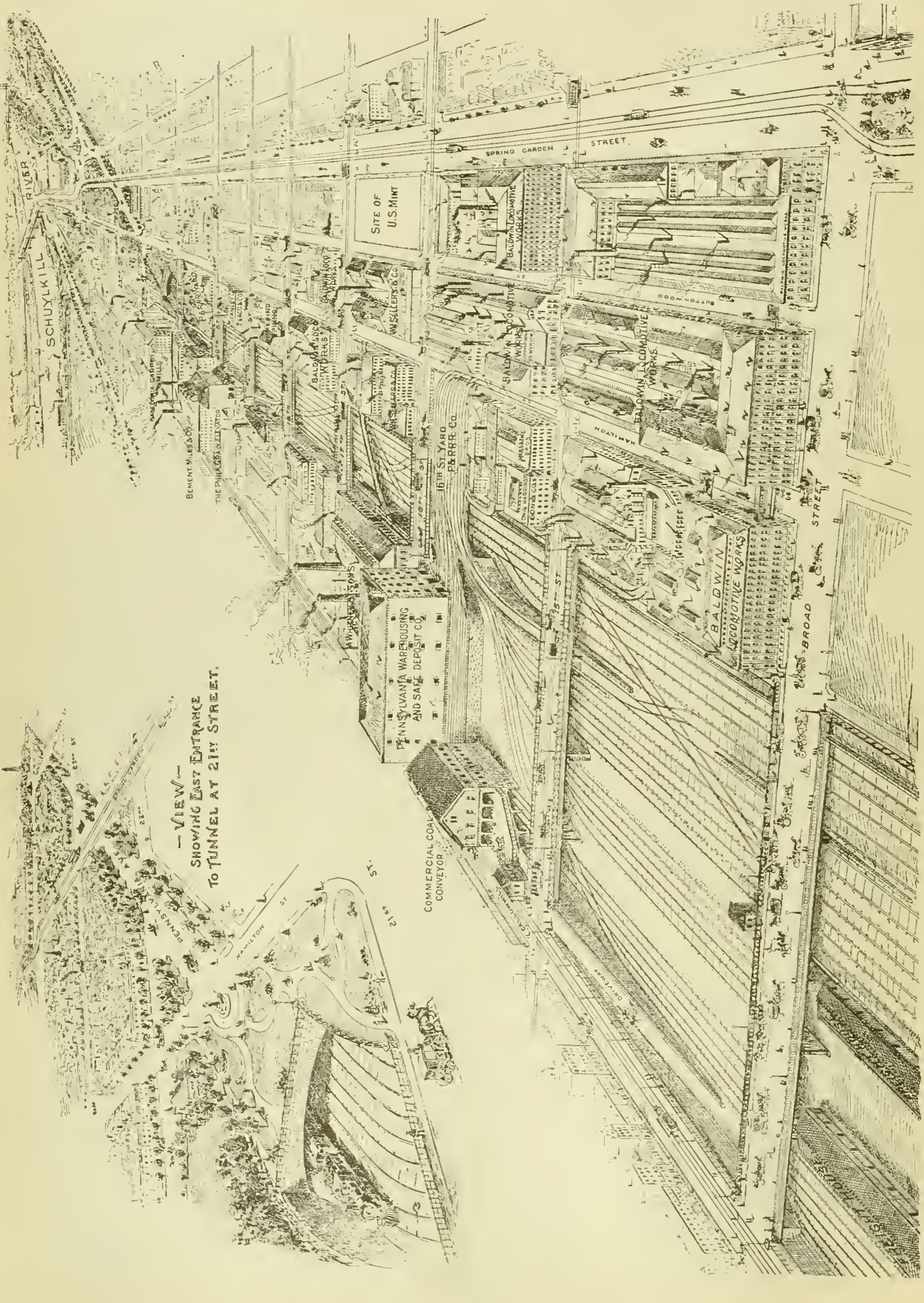


FIG. 1—PERSPECTIVE VIEW, SHOWING PENNSYLVANIA AVENUE SUBWAY AND TUNNEL AS IT WILL APPEAR WHEN COMPLETED

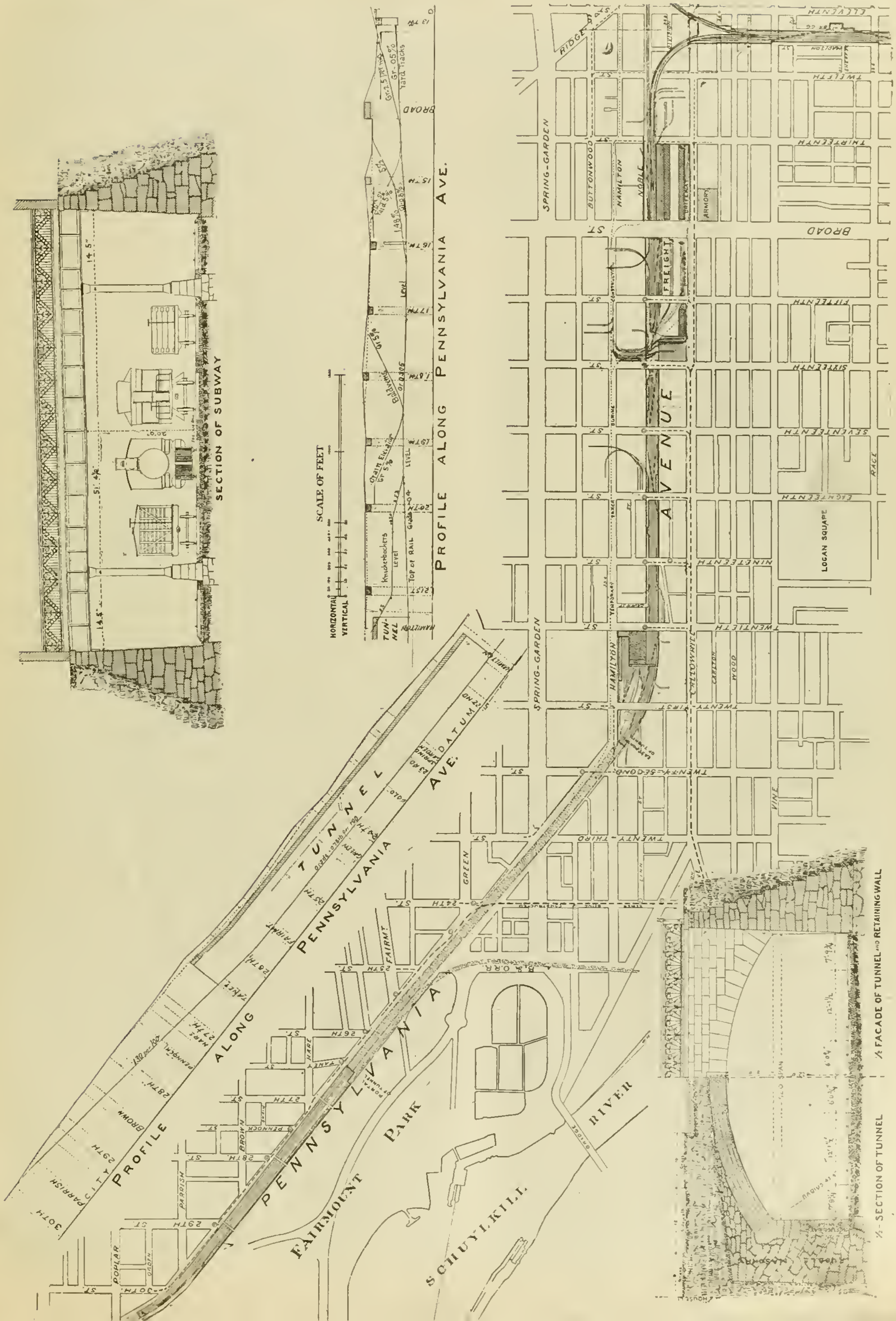


FIG. 2. PLAN, PROFILE AND SECTIONS OF PENNSYLVANIA SUBWAY AND TUNNEL.

carried over the subway at Twenty-seventh, Twenty-eighth and Twenty-ninth streets.

In Figs. 2, 3 and 4 are given sections that are each typical of the masonry work. The tunnel section we have already alluded to; the dimensions of the retaining walls are given in Fig. 4; if at any point it is of greater height than shown the wall is carried down with steps of 18 inches every 4 feet as shown. The section of a bridge abutment is likewise typical. The section showing the relation between the retaining wall and the foundation of adjacent buildings that must be under-pinned during construction is only one selection from many cases. In some instances the entire front of buildings must be removed and rebuilt. The retaining walls are to be built in an open trench, and are to be of rubble masonry laid in Portland cement (1 part cement to 3 parts sand), with a coping 10 inches thick. After the completion of the walls the core of earth between them will be removed, that work being a separate contract.

In the construction of the tunnel the tracks will be thrown first to the one side of their present location and then to the other side, to permit of the construction of the side walls. Then after the removal of the core the arch will be constructed. The side walls are to be of large rubble masonry laid in Portland cement of the same quality as for the retaining walls. They are to have refuge bays in them at regular intervals. The brick arch is to be laid in natural cement mortar and terminated at the ends by stone voussoirs. The entire surface of the extrados of the arch and over the spandrel filling is to be plastered with natural cement mortar ¾ inch thick.

The ventillation of the tunnel will be accomplished through two fan stations on the north side of the tunnel, one located near Twenty-third street and the other between Twenty-fifth and Fairmount avenue. Each station is to have two large slow-moving fans, driven by electric motors, each of a capacity of 150,000 cubic feet per minute, or a total of 600,000 cubic feet for the four. They will be able to remove air equivalent to the total volume of the tunnel every five minutes. Into these fan houses conduits enter from both directions. Each has four openings into the tunnel of 35 square feet area, and the conduits begin with a diameter of 6 feet 6 inches at their further ends and increase to 11 feet at the fan houses. One of these is seen in the section in Fig. 3. On the south side of the tunnel ten fresh-air intakes are provided. They are not located directly opposite the exhaust openings, as might be inferred from Fig. 3, but at intermediate points. The openings for the intakes are covered with cast-iron gratings. The exhaust conduits are to be of brick laid in natural cement mortar, with a cradle of rubble masonry or concrete. The arch generally is to be 13½ inches thick and the invert 4 inches. At the exhaust openings they are to be bonded into the brick tunnel arch and the lines of intersection of the cylinders formed by the opening and the arch are to be constructed of fine pointed cut stone.

The highway bridges built over the subway at various points are all of the plate girder deck type, with solid floors covered with concrete, on which is laid 3 inches of asphalt. Where the street is on a heavy grade, the roadway is to be paved with vitrified brick instead of finished with asphalt. The railroad bridges are also to be of the same type, with solid floors, covered with ballast.

As already stated many new sewers had to be laid preparatory to the construction of the main work. Altogether 3½ miles of sewer varying from 12 inches to 10 feet 6 inches in diameter have been laid at depths of from 20 feet to 40 feet below the surface of the streets, at a total cost of about $500,000. In order to cause the minimum of inconvenience 65 per cent. of the sewer work was constructed in tunnel.

The engineering difficulties in the construction of a work of such magnitude are many and various. Among the most serious in the present instance may be mentioned the work of under pinning, and supporting the many large buildings, warehouses and elevators while the excavation is carried on practically beneath the foundations, and the masonry retaining walls built. The blasting of the rock near such structures requires the utmost care and good judgment. Special machinery for excavating will be required, and water and gas pipes and electrical conduits must be taken care of.

As already stated, the Department of Public Works of the City of Philadelphia has prepared all plans and specifications. The officials in charge of the work are: Mr. Thomas C. Thompson, Director of the Department of Public Works; Mr. Geo. S. Webster, Chief Engineer, Bureau of Surveys; Mr. J. M. Wilson, Consulting Engineer, P. & R. R. R. Co.; Mr. G. E. Datesman, Principal Assistant Engineer, Bureau of Surveys; Mr. S. T. Wagner, First Assistant Engineer, in charge of the work; Mr. R. I. D. Ashlidge, Second Assistant Engineer, in charge of construction; and Mr. Chas. H. Swan, Chief Draughtsman.

Should a Railroad Adopt Electric Motive Power to Meet the Competition of Electric Suburban Lines?

To what extent a railroad shall strive to retain the traffic which electric lines, actually constructed or contemplated, will otherwise take from them, is a question which a number of railroad companies have already had to consider. It is ably discussed in the twenty-seventh annual report of the Massachusetts Railroad Commission (issued under date of January, 1896), in a chapter devoted to electric motive power. In the same chapter the status of electricity on steam roads is also discussed, and while the conclusions of the Commission may not differ from those of other thoughtful students of the problem, they are so well expressed that we quote from them. The Commission says:

"Whether, taking everything into account, it is as practically convenient and economical to generate at a central station the power of 20 steam locomotives, and by the electrical distribution of this power over the lines of a railroad to move that number of trains, as it is to distribute over the lines 20 steam locomotives, each generating its own power, to haul the trains, is the gist of the question which is at issue between steam and electricity as the better motive power for general railroad operation.

"This question does not as yet admit of a categorical and unqualified answer. In the present stage of electrical development, and in the light of such experience as has been had in the actual use of electric power in railway and railroad operation, the most definite answer that can be given, or that has been given by experts and practical railroad men, amounts to this: The more closely a given railroad service resembles in character that of the ordinary street railway, the better the adaptation to that service of electric motive power; and, conversely, the less the resemblance, the poorer the adaptation. In other words, the most efficient and economical use of electric power will be found where there is a considerable and steady volume of local and short-distance travel, which requires or or justifies the running of numerous light passenger trains, at short and regular intervals, so that the trains will be constantly and uniformly distributed over the railroad line. The most efficient and economical use of steam power, on the other hand, will be realized were the traffic is concentrated in heavy trains, run at infrequent and irregular intervals, in accordance with the usual method of conducting through or long-distance transportation.

"In passenger traffic, the public demand and the railroad policy have been in the direction of more frequent and quicker trains. In freight service, on the contrary, where there is no such pressure or occasion for frequent trains at high speed, the policy has been in the direction of fewer and heavier trains. The whole tendency of modern railroad development has been to cut down grades and to increase the weight of engines and of tracks, so as to enable a single locomotive to haul a heavier freight train load. It has been estimated by good authority that doubling the number of engines for a given traffic increases the cost of transportation about 50 per cent. The general tendency of passenger traffic may therefore be said to lie in the direction in which electricity is the most serviceable, while the reverse is true as regards freight traffic.

"With respect to speed, extraordinary claims are made by those interested in the development of electric traction, but there is no question that the steam locomotive is fully capable of developing as high a speed as it is desirable or prudent to use. A railroad speed of 100 miles or more an hour is, for the present purpose, a matter of merely curious speculation. It cannot be shown that there is enough traffic demanding this speed to pay the excessive expense of operation, even if with present methods of construction and equipment it were otherwise at all practicable. Before any such speed is seriously thought of, there must be radical improvements in safety appli

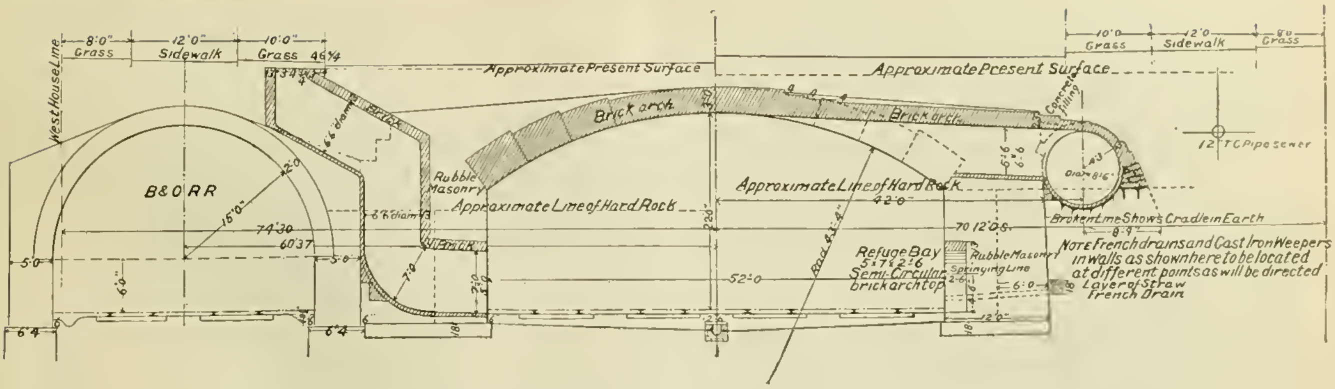


Fig. 3. Section Through Philadelphia & Reading and Baltimore & Ohio Tunnels.

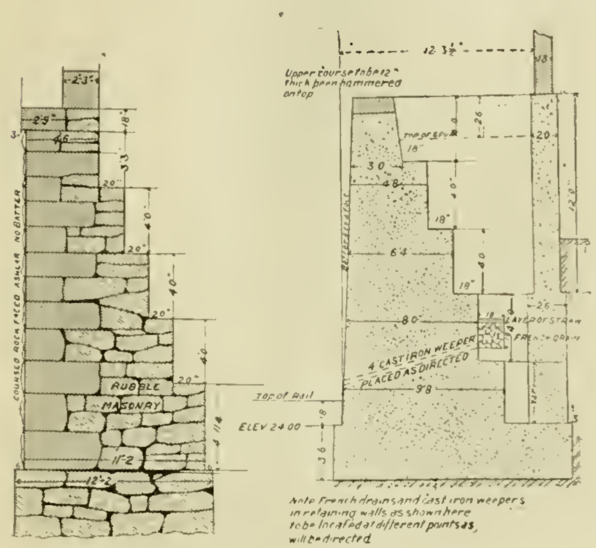


Fig. 4. Sections of Abutment and Retaining Wall.

ances, as, for example, in brakes and in signals. Whatever the proposed rate of speed, the question of signals becomes at once of importance, since, with the adoption of electricity, all systems of electric signaling which depend on the use of the rail circuit must be modified or abandoned.

"It is admitted that electricity is not suited to the moving of freight traffic, and it is not claimed that it is economically adapted to the moving of long-distance passenger traffic. Its province in railroad operation must therefore be, if anywhere, in moving suburban passenger traffic, or short distance inter-urban and local passenger traffic, or the isolated traffic of branch and spur lines. The question is, therefore, for the present narrowed down to the expediency of its use for these, or for some of these, last-mentioned purposes.

"Whatever the proposed purpose, the question is one of economy. In other words, will it, on the whole, *pay* to substitute electric for steam power?

"The first cost is, of course, an essential point. This would depend on the amount of traffic to be served and the comprehensiveness of the plan. The work must include not only the erection and equipment of power stations, the electrical equipment of the line, and the provision of suitable rolling stock electrically equipped, but the preparation of the roadway and its appurtenances for the new system of operation. For a road with local traffic only, there should be at least two tracks. It is evident that through trains and the numerous electric trains could not be run on the same tracks; so that, if both kinds of traffic are to be conducted on the line, there must be not less than four tracks. The facilities and accommodations at terminal stations, if not the stations themselves, to say nothing of way stations, must be enlarged and adapted to the additional service. An electric train or car running at a speed of 30 or 40 miles an hour would be as fatal to a traveler on the highway as an express train; and the frequency of such trains, in addition to the through trains, would require the elimination of all grade crossings with public and private ways, as well as with other railroads. The necessity of reorganizing or replacing the electric signal systems has been already referred to.

"The above are some of the principal items of first cost. The outlay would evidently be large, especially on main and trunk lines. The cost of double tracking and electrically equipping the Nantasket Beach Railroad, seven miles long, for summer traffic, appears to have been about $300,000. The first cost must, of course, be capitalized or funded. In order to justify the investment, it should be shown that the earnings will be increased, or the expenses diminished, by an amount sufficient to pay the dividend and fixed charge on the stock issued and debt incurred, and to leave a margin for contingencies and for years of poor traffic.

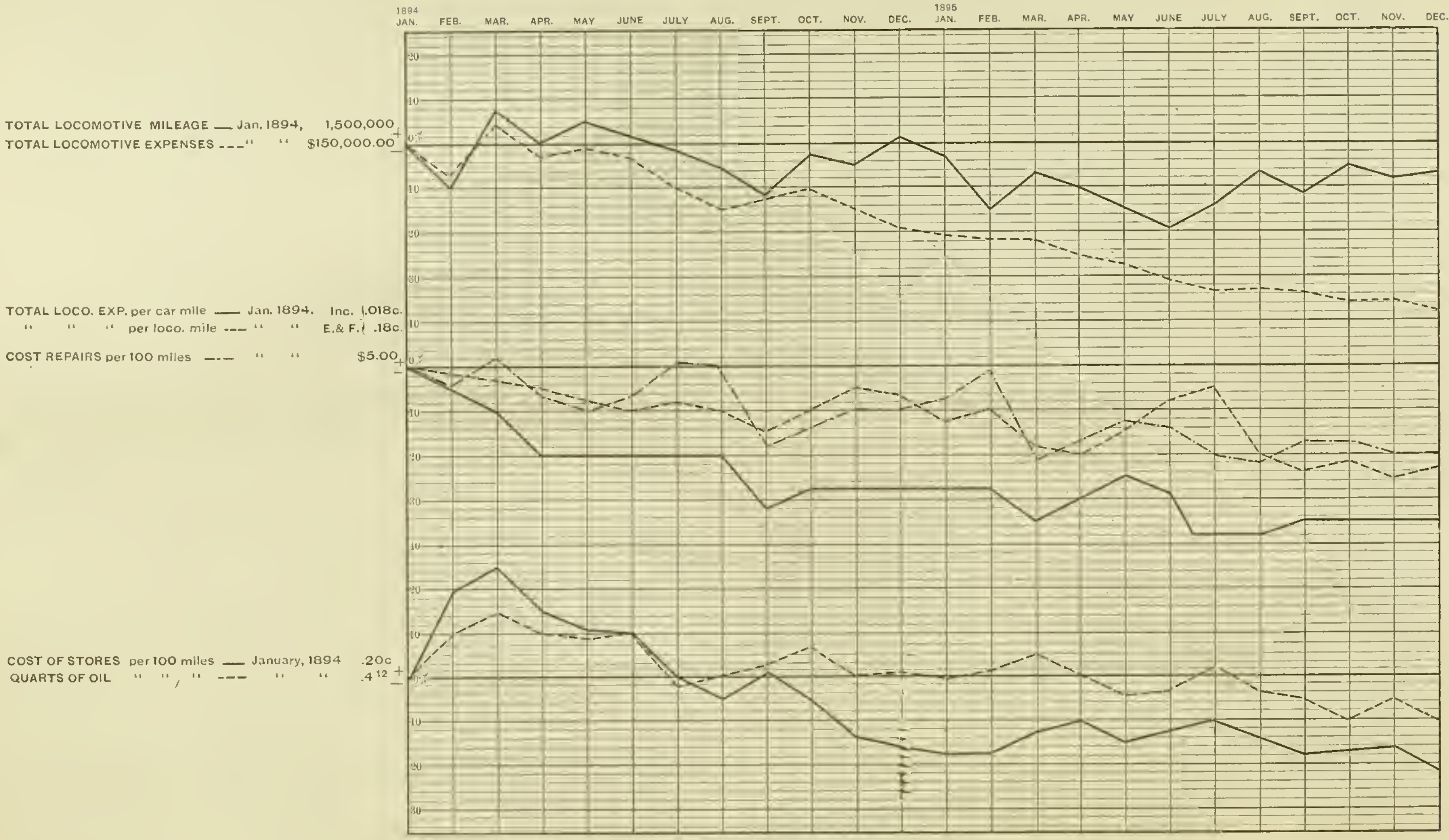
"Nothing can be added to what has been said about the probable expense of maintenance and operation, as compared with steam power. If there is no ground to warrant the assertion that it will be greater, there is as yet no evidence that it will be less. This is an unknown factor in the case, which time and experience must resolve.

"As the whole case now stands, and until further electrical development, we venture the following as the safer conclusion: On a branch or spur line, where the operation may be independent of the main line, and where the present traffic, while not large enough to make steam power profitable, is not too small to be developed into a paying business by a service conducted substantially on the street railway plan of operation, it may be advisable to substitute electric for steam power. There is not, on the other hand, as yet sufficient ground to justify the vote of a prudent stockholder in favor of such substitution on the main lines of a corporation which has a considerable through as well as local traffic, and whose present business is established, remunerative, and reasonably secure."

The Commission then makes a comparison between the electric street railway and the steam road for short distance traffic and finds that the choice of the traveling public is influenced by, 1st, comfort of travel; 2d, speed of conveyance; 3d, frequency of service; 4th, rate of fare; 5th, convenience as regards traveler's point of departure and destination. Of these, the first two are in favor of the steam road, and the last three are on the side of the electric street and suburban system. But it shows that while the third point mentioned above might be met if the steam road adopted electricity, the fourth and fifth could not. The expensive right of way of the steam road and the free use of the city streets by the electric line makes too great a difference in the fixed charges to enable the steam road to make money at the rates of fare charged by the competing electric lines. On the other hand, the controlling advantages as regards long distance travel and freight traffic are decidedly with the steam road. Continuing, the Commission says:

"Nothing will be gained, either by the railroad or the electric railway, by an attempt to control the class of traffic which the other is the better adapted to serve. Neither is the attempt to be encouraged in the public interest. Experience has abundantly proved that there is no advantage to be derived from the establishment of two similar agencies to perform the same specific public service. Competition of this sort leads to combination and ends in consolidation. It is like the unwisdom of laying two gas mains in the same street, for one of which the public has no need, but for both of which the public in the end must pay.

LOCOMOTIVES: Cost of Operation.



A GRAPHICAL METHOD OF RECORDING LOCOMOTIVE EXPENSES.

"If the diversion of short-distance traffic were likely to cripple the resources of the railroads, the question would have for them a more serious import. We anticipate no such result. The disturbing element is not of recent origin. It began with the horse railway; and it is now some seven years since the electric railway has been fastening upon this traffic its farther reaching and more tenacious grasp. Meanwhile, up to the inception of the recent business panic, the traffic and revenues of our railroads kept on rapidly growing year by year. But for the exceptional stringency of the times, there is no reason to doubt that they would have continued steadily to increase. With only a partial recovery from general commercial depression, the net earnings of our railroad companies were larger the last year than in any previous year in their history.* With years of returning prosperity we venture to predict that their traffic and revenues will grow in the future as they have grown in the past.

"Whatever the diversion of short-distance travel, the increase of population and industry which the electric railway will foster and develop along the railroad lines, will still be tributary to the latter in a hundred ways.

"It is, perhaps, unnecessary to add, that there is no apparent demand by the public for the substitution of electricity for steam in general railroad operation. No complaint has come to our ears that the present railroad service, so far as the motive power is concerned, is inadequate or unsatisfactory. The question, as it now stands, is one purely of economy, to be decided by the railroads primarily in their own interest, bearing in mind, as they will, that it is always for their interest to give to the public the best service reasonably in their power. Our railroad managers, we have reason to know, are giving to the subject their diligent attention and study; and they will be alert to introduce the new motive power upon their lines so soon as it shall become manifest that by so doing they can give to the public a substantially cheaper and better service."

* This, of course, refers to the railroads in the State of Massachusetts.—EDITOR.

The Use of Graphical Methods in Keeping the Accounts of Railway Mechanical Departments.

The value of the graphical method of recording and comparing statistics of various kinds is so generally recognized that its use is daily extending. It has frequently been used in railroad circles, but until recently we have not found it employed systematically and regularly in recording the various monthly expenses of a mechanical department. Such a use of graphics on a large railroad system entering Chicago recently attracted our attention, and through the kindness of the superintendent of motive power, we have been furnished with interesting particulars. We have been asked not to name the road from which our information is obtained, but a few of our readers in official positions have already investigated the workings of the system, and have been charmed with it, and we can probably put others on the track of any additional information they may require.

In establishing the graphical records on the road alluded to, the expenses for the month of January, 1893, were taken as a basis, and the percentage of increase or decrease in each item was calculated and shown graphically. Three separate sheets were decide upon, one for shops, one for cars and the third for locomotives. Not more that three items are grouped under one set of lines, though there may be several such groups on the one sheet or chart. On the sheet for the shops is shown the total locomotive mileage, the total car mileage, the total material received, the total material charged out, the material on hand, the total shop labor, excluding engineers' and firemen's wages. Under the heading of cars is shown the passenger car mileage, the cost of passenger car repairs per mile, the cost of passenger car lubrication per 1,000 miles, the cost passenger car cleaning per car; the total freight car mileage, freight car mileage loaded, freight car mileage empty, cost of freight car repairs per mile, and cost of freight car lubrication per 1,000 miles. Under the sheet for locomotives is given the total locomotive mileage, total motive power expenses including engineers' and firemen's wages, the total motive power expenses excluding engineers' and firemen's wages. the total locomotive expenses, total locomotive expense per car mile, total locomotive expense per locomotive mile, cost of repairs per 100 miles including new locomotives, cost of locomotive repairs per 100 miles excluding new locomotives, cost of fuel per 100 miles, pounds of coal per passenger car mile, pounds of coal per freight car mile, cost of lubrication per 100 miles, quarts of oil per 100 miles, passenger and freight, and cost of stores per 100 miles.

The records are kept on tracing cloth 22½ by 44 inches, ruled like profile paper. These tracings are filed in the drawing room and kept up to date by the draftsman through information furnished him each month.

In the illustration on page 100 we reproduce a part of the locomotive sheet showing seven of the items mentioned. It is a facsimile as far as the general arrangement is concerned, but the values given are fictitious, although approximate, and they refer to January, 1894, as a basis. The diagram is ruled with vertical lines representing the months, and at each group of items there is a heavy horizontal base line with parallel rulings above and below it, for each two per cent., those above representing increase and those below, decrease. The percentage of increase or decrease for each item is laid off on each monthly line, and the points connected with a line of a character designated on the left-hand margin. Thus the locomotive mileage which in January, 1894, was 1,500,000, was 10 per cent. less in February, and 8 per cent. more in March of the same year. In December, 1895, it was 7 per cent. less, while in the meantime the locomotive expenses decreased nearly 38 per cent.

In the same way we are shown in a striking manner the falling off in the cost of repairs, in the cost of stores, and in the locomotive expenses per car and per locomotive mile. It needs no argument to convince any reader that the expenses of the department are shown up in a more comprehensive manner by this graphical method than can possibly be done by the use of tables of figures, however carefully they are prepared. This graphical system is worthy of extensive use in mechanical departments, and where adopted it might lead to economies, the need tor which is not at present realized. In our example the falling off in expenses is of course to be largely attributed to the temporary retrenchment which that road in common with others has had to practice in the last two years.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.—Second Series.—Chemical Methods.

XVIII.—Method of Determining the Fineness of Grinding of Freight Car and Passenger Car Color.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

In the purchase of paints there is always a question in the mind of the consumer as to the fineness of the grinding. And since it is well known that not only the satisfactory working of the paint under the brush, and the appearance of the surface when the painting is finished, but also the durability of the work is affected by the fineness to which the paint has been ground, it is obvious that the grinding of paint is an important matter. Moreover, as paints are ordinarily ground, from 10 to 20 per cent. of the price of the paint is for the grinding, and as it would be easy by insisting on much finer grinding to increase the cost 20 to 30 per cent., it is clear that the financial side of paint grinding is not its least important phase. Several methods of determining the fineness of grinding have been proposed. One of these is to put a little of the paint on one thumb nail and rub it with the other. If there is no scratching or gritty feeling the paint is supposed to be finely enough ground. Experience shows, however, that both the nature of the pigment, and the nature of the menstruum used along with the pigment, as well as the individual characteristics of the operator, all affect this test, so that its indications cannot be regarded as sufficiently reliable to be of much value. Another test is to mix with the paint quantities of some liquid which dissolves the menstruum completely, and does not dissolve the pigment, and then see if the whole mass, pigment and liquid together, will run through a sieve which has been decided on as the standard of fineness. For example, if 100-mesh or 150-mesh sieve has been decided on as the standard of fineness, it is obvious that if part of the pigment is left on the sieve, the paint was not finely enough ground. Still another test of similar nature is to separate some of the pigment from the menstruum and examine the dried pigment under the microscope, measuring the size of the particles if desired. It is obvious that both these tests simply tell something in regard to the fineness of the pigment. They do not give any information as to how well the pigment is mixed with the menstruum, which is one of the important elements in the grinding of paint. Indeed, experience shows that with either of these tests it would be quite possible to pass paint as well ground which had never been in a mill at all, it having been simply mixed in a "chaser.". Moreover, it is very difficult to get a sieve which even approximates in mesh the fineness desired in well-ground paints. Also in the miscroscope test there is very great difficulty in being sure that aggregations of particles are not being measured instead of the particles themselves. In view of these difficulties, it is clear that there is need for some test which shall be definite and positive, which shall give results always alike, which shall be unaffected by the individuality of the operator, and which shall tell what it is essential to know, viz: (1) That the particles of the pigment are themselves sufficiently fine, and (2) that they are properly mixed with the menstruum. It is believed that the test which is described below accomplishes these results in a satisfactory manner. The test is described as applying to paints purchased in the paste form only. It is thought, however, that the principles involved in the test being made clear, modifications of the method can readily be made which will make it applicable to all kinds of paints, with the possible exception of those in which the proportions of pigment to liquid are outside the limits of the test.

OPERATION.

Weigh into a small porcelain dish in the case of freight-car color two (2) grammes of the paste, and add one (1) gramme of pure raw linseed oil, and in the case of passenger-car color five (5) grammes of the paste, and add three (3) grammes of pure raw linseed oil. Stir with a glass rod having a rounded end, until the material is a homogeneous mass. Have ready the cooling chamber and the strips of glass described below, which have been brought to a temperature of 70 degrees Fahrenheit by passing warm or cool water through the cooling chamber. Place the dish containing the material to be tested in the cooling chamber, and allow it to stand half an hour. Then stir thoroughly again and with the glass rod place a few drops of the material on one end of one or more of the strips of glass, place the glass vertically in the cooling chamber, with the end containing the spot of paint uppermost. Replace the cover and allow it to stand for half an hour. The material runs down the glass in a narrow stream. At the end of the time remove the cover, and examine the strips of glass, best by holding them between the eye and the light. If the liquid has not separated from the pigment for an inch down from the top of the test, that is, if the stream of paint is smooth, continuous and completely opaque for this distance, the paste is sufficiently fine ground. On the other hand, if the liquid has separated from the pigment, leaving little patches and ridges of pigment, and apparent rivulets down which the liquid has passed, leaving more or less pigment behind, the stream of paint being more or less rough and irregular on its surface, and more or less transparent, the paint is not sufficiently well ground.

APPARATUS AND REAGENTS.

Any convenient porcelain dish will do for the mixing of the paste and oil. One 2½ inches in diameter across the top and 1 inch deep does nicely.

The cooling chamber may perhaps best be described as one metallic box inside another one, the spaces between the two being filled with water of the proper temperature, and the inside box being fitted with a cover. In order to make the construction clear, let us describe as follows: Make a completely closed box of sheet copper 10 inches square and 8 inches high. In the top cut a hole 6 inches square. Into this hole slip another sheet-copper box, 6 inches square and 6 inches deep, but without a top. Make all joints tight. Fit the 6-inch box with a removable cover. Make two holes, half an inch in diameter, in the top of the larger box to serve as inlet and outlet for the cooling water, and into one of which a thermometer may be placed to take the temperature of the water. It will be seen that we thus have the inside box as a cooling chamber, surrounded on five sides by a layer of water approximately 2 inches thick. The cover being placed on the smaller box, it is evident that the space inside the smaller box, or any articles placed in it, will, after a proper time, become very closely the temperature of the layer of water. If now this is adjusted to 68 or 69 degrees Fahrenheit, the temperature of the chamber will be very near to 70 degrees Fahrenheit, the desired temperature, if, as is customary, the apparatus is used in a room or laboratory which is kept from 70 to 80 degrees Fahrenheit.

The strips of glass used are about an inch wide and 4 inches long. They should be dry and before use should be brought to the same temperature as the cooling chamber, by standing them vertically around the sides of the chamber for at least half an hour.

The linseed oil to be mixed with the paste should be pure raw oil, and should not be allowed to get old.

CALCULATIONS.

The results of this method being simple observations, no calculations are required.

NOTES AND PRECAUTIONS.

It is evident that this method depends for its success on the fact that a moderately viscous liquid like linseed oil does not separate from particles of solid matter, under certain conditions. The principal conditions which have been found to affect the test are as follows: 1st, the temperature; 2d, the proportions of pigment and liquid; 3d, the nature of the liquid; 4th, the nature of the pigment; 5th, the completeness with which pigment and liquid are mixed, and 6th, the fineness of the pigment. It is not claimed that no other conditions affect the test, but these are believed to be the principal ones.

It is obvious that by increasing or diminishing the temperature at which the test is made, the viscosity of the liquid is increased or diminished, with consequent increase or decrease in its ability to leave the pigment. The higher the temperature, the more limpid the liquid, and the less its likelihood of staying with the pigment.

The proportions of pigment and liquid have a very important influence on the test. Indeed it is this variable which is generally used in applying the test to various kinds of paints. The proportions given under "Operation," as applying to freight-car color, are different, it will be observed, from those applying to passenger-car color. These proportions are determined by experiment, and may be different for every kind of paint, depending on the nature of the pigment, the nature of the menstruum in which the pigment is ground, the temperature at which the test was made, how completely the pigment and liquid are mixed, and especially the fineness desired. The standard freight-car color of the Pennsylvania Railroad Company is a mixture of about 75 per cent. pigment, with 25 per cent. of pure raw linseed oil, both by weight. The pigment is a mixture of about 25 per cent. of sesquioxide of iron, with 75 per cent. of inert material, partly clay, partly sulphate of calcium, partly silica and partly carbonate of lime. With this pigment and this liquid, it will be observed that the proportions in the mixture which is subjected to test for fine grinding are one-half pigment and one-half liquid by weight. (Two grammes of paste are taken, of which 1½ grammes are pigment, and one-half gramme oil. One gramme of oil is added, making 1½ grammes of pigment, and 1½ grammes of liquid.) The standard passenger-car color of the Pennsylvania Railroad Company is a mixture of about 75 per cent. pigment, and 25 per cent. liquid by weight. The liquid is a mixture of about 36 per cent. pure raw linseed oil, and 64 per cent. of spirits of turpentine, also by weight. The pigment contains approximately 80 per cent. sesquioxide of iron, 5 per cent. carbonate of lime, from 5 to 10 per cent. of wood or other lake, and a little inert material. With this pigment and this liquid, it will be observed that the proportions in the mixture which is submitted to test for fine grinding are about 47 per cent. pigment and 53 per cent. liquid by weight. (Five grammes of paste are taken, of which 3¾ grammes are pigment, and 1¼ grammes are liquid. Three grammes of oil are added, making 3¾ grammes of pigment, and 4¼ grammes of liquid.) It would be easy, by varying the proportions of pigment and liquid either way from the figures given, to increase or diminish the severity of the test. A recent attempt to increase the fineness of the grinding of the standard freight-car color, so that the proportions used would be two grammes of paste and two grammes of oil, or about 40 per cent. pigment to 60 per cent. liquid, brought from the manufacturers the statement that to do this would compel them to charge at least 25 per cent. more per pound for the material.

The influence of the nature of the liquid on the test is not difficult to understand. If a paint is ground in japan or varnish, it is clear that the results would be quite different, the test being otherwise the same, than if raw oil or oil and turpentine were used. The more viscous the liquid, or the more the adhesion between pigment and liquid, due to its stickiness, the coarser the grinding may be, and still the material stand the test as above described. Of course by modifying the conditions, such as increasing the proportions of liquid or adding to the paste, turpentine or some other limpid liquid, instead of oil, entirely satisfactory results may be obtained, whatever the nature of the liquid used in grinding the paint. Moreover, direct experiment shows that by adding a single drop of water to material which does not quite stand test, and stirring with the glass rod until the water is uniformly mixed, the material will stand test. The addition of the water apparently converts the oil into an emulsion, which remains with the pigment better than the oil alone. Furthermore, if the oil added to the paste is old, and has become in consequence what the painters call "fatty," shipments will not stand test which are satisfactory when fresh raw oil is used. Apparently the old or fatty oil being changed or different in its nature from fresh oil does not adhere to the pigment as well as the fresher oil. Whatever the explanation, the fact remains.

It seems evident that the nature of the pigment, especially its specific gravity, its mechanical condition, whether compact or flocculent, and especially whether the liquid used wets or adheres to it, or is repelled by it, have an important influence on the test. The exact influence of each of these variables has not yet been worked out.

The influence of the mixing of pigment and liquid on the test may be made quite evident by separating and drying some pigment from a sample of paste which stands test all right, and then mixing some of this pigment with the proper amount of oil, and stirring with a glass rod, and finally submitting some of the material to the test again. It will be found that no amount of stirring, notwithstanding the pigment is so fine that it has once stood test, will ever bring the material into the same condition that it was left by the mill before it was first submitted to test. It seems almost impossible to break up all the aggregations of particles of pigment, and mix them uniformly with oil or liquid by any other means than the mill or its equivalent.

Perhaps the best illustration of the effect of the fineness of the pigment on the test may be obtained by testing any sample of paste for fine grinding, and then passing it through a mill again, testing it again, and so on, taking care to tighten the mill each time before regrinding the paint. It will be found that each grinding, if it is properly managed, makes the material stand a severer test, as shown by the fact that continually more and more oil may be mixed with the paste and still the sample stand test.

It is obvious that this test gives no absolute standard of fine grinding, and that different paints made from different pigments and liquids cannot necessarily be compared with each other by means of it. The query may arise as to when a paint can be said to be ground finely enough. The answer is that this is a question of the uses to which the paint is to be applied, and of money. For freight-car work, or for the outside of buildings, it would probably be poor policy to grind paints as finely as for passenger-car work, or for the insides of rooms or carriage work or artists' work. On the other hand, there is no doubt but that, for most paints at least, the finer they are ground the more surface they will cover, the more durable they will be, and the more economically and successfully they will be used in the shop, giving at the same time a better job. But, as already stated, the grinding of paint is an expensive process, and, therefore, in each case, how fine the paint shall be ground must be decided by the conditions.

It may be thought that the stirring with a glass rod to mix the added oil with the paste will have an influence on the test. Experience indicates, however, that the influence of stirring, if any, is so slight that its effect can be ignored.

The direction not to use old or fatty oil has already been commented upon, and the influence of this explained. The effect of water mixed with the paste has also been mentioned. It should also be stated that if a little alkali, caustic or carbonate of soda, or potash, or wood ashes, or caustic lime is added to the paint during grinding, it will stand test with a good deal coarser grinding than if none of these substances are present. In all critical cases it is essential to prove the absence of these materials before being satisfied that the paint is ground sufficiently fine.

Tests may be desired of paints which contain such large proportions of liquid, and such small proportions of pigment, or in which the liquid is so limpid, that however finely the paint may have been ground, the liquid will separate from the pigment when tested. It is obvious that this method does not apply to such paints as these. It is also evident from what has preceded that the same standard of fine grinding does not apply to all paints, but rather that each kind of paint has its own standard, which standard is determined by experience and the conditions of its use.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—VI.

BY OSCAR ANTZ.

(*Continued from Page 75.*)

DRAFT GEAR—CONTINUED.

There seems to be a tendency with many car builders at the present time to use metal instead of wood in the construction of certain parts of cars, where it can be done to advantage, where, for instance, the parts can be made stronger, lighter, cheaper or less difficult to apply in metal, or where the wood is more than usually subject to decay. No general attempt has yet been made to substitute metal for wood for draft timbers, although in some individual cases of special cars built almost entirely of metal the draft timbers are also of the same material.

A step in this direction has, however, been recently made in the introduction of a device in which "draft arms," made of malleable iron, are substituted for the draft timbers, the drawbar stops and other attachments being made part of the same casting. Figs. 31 and 32 show this arrangement as applied to a car; *A A* are the malleable iron draft arms, which are made in pairs, and each is fastened directly to the sills and face block by four 1-inch bolts, having heads resting in socket castings let into the floor. These draft arms have flanges cast in them at *B B*, against which the followers *C C* rest, forming a front drawbar stop. At the rear end of the draft arms are fastened the back drawbar stops, *D D*, which are held each by one of the bolts through the center sills, and transversely by two bolts passing through both back stops and both draft arms, the back stop acting as distance pieces. Into these back stops are fitted wooden subsills, *E E*, bolted to bottom of center sills and extending, if possible, back to the crosstie timbers; similar blocks may be fitted between the latter timbers, forming practically a continuous draft timber from end to end of car, to take butting strains. To take pulling strains, flanges are provided on the outside of the draft arms for the reception of the nuts of the draft rods, *F F*, which extend to and through the crosstie timbers, with nuts on the back of these. Similar rods tie together the cross-tie timbers.

Drawbar guides, *G G*, are provided on the bottom of the draft arms, the upper guide being formed by the casting itself. The front end of the draft arms is provided with a shoulder, which rests against the projecting portion of the face block, *H H*. Lugs, *I I*, cast on the inside faces of the arms, form guides for the front end of the drawbar. A carry iron, *JJ*, of the usual shape is provided under the face block, and just back of it, under the end sill, is

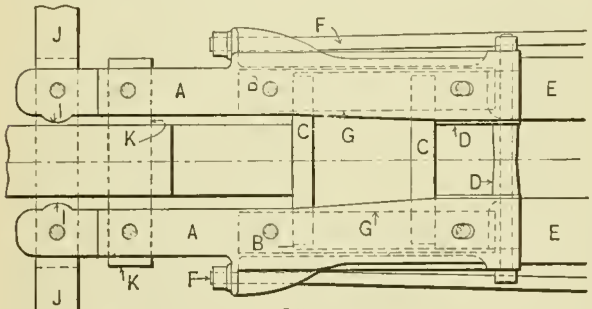


Fig. 31

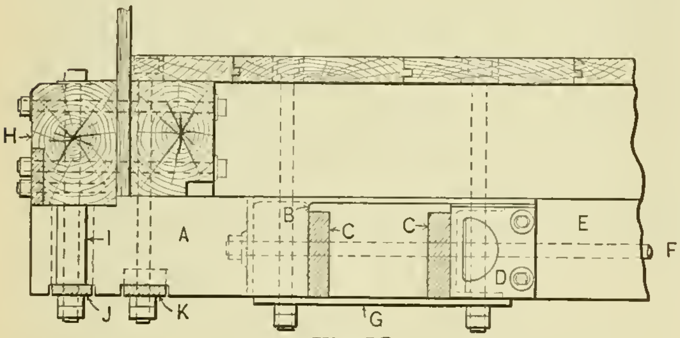


Fig. 32

located an additional tie strap, *K K*, both carry iron and tie strap being let into recesses in the bottom of the arm.

The draft arms shown in the drawings is proportioned for follower plates to take two springs side by side, but of course they can be made for the standard length of follower plate just as well.

DRAWBARS.

The one part of the draft rigging of cars, which has undoubtedly received the most attention, is the coupler or drawbar. The freight couplers in this country, while varying greatly in detail, yet combine in nearly all of them, the general principles of simplicity, ease and rapidity of operation, and in this respect differ so much from many styles in use in other countries, that a passing remark about these will not be out of place. The general idea of most of these foreign couplers is that of a link on one car, passed over a hook on the other and combined often with a more-or less elaborately arranged system of screws, levers and springs, by means of which the cars are drawn closely together when coupled; the time and care necessary to couple cars with these contrivances seem entirely out of place to American ideas.

In the early days of railroading this hook and link found its way into American equipment and is still found as the so-called "three link" coupling on some of the four-wheeled coal cars in use on a few of the roads in the Middle States, but is being retired with this class of cars.

The distinctive American coupler of the earlier days is the link-and-pin coupler, in which the drawbars are made with pockets for the reception of a link connecting the two bars, which is secured in each bar by a pin passing through each end of the link and through holes in the bar; this coupler is now considered obsolete and no sketch of it is, therefore, given. Link-and-pin drawbars have been made of cast, wrought and malleable iron, each metal requiring some shape peculiar to itself. Connection to the draft gear was made at first by means of the spindle or tail pin, but was eventually superseded on many roads by the spring pocket or yoke, or some continuous attachment. In coupling cars with the link and pin, the link must be secured in one drawhead and held up and entered into the other drawhead when skill and is attendant with considerable danger to the switchman, who has to step between the cars to make a coupling. To avoid this danger, a great many devices have been gotten up in connection with this style of drawbar, from a simple rod or stick in the hands of the trainmen, to more elaborate ones combining a mechanism to hold up the link with another to drop the pin, but none of these devices have stood the test of severe service on the road, although some of them seemed to possess at least some good points.

Other inventions were introduced doing away entirely with the link and pin and substituting lugs or similar contrivances projecting from the drawbar which interlocked with each other, and eventually the design, which is now considered a standard in this country was devised. It is the policy of the M. C. B. Association not to recommend any article of a particular manufacture, and no particular coupler is therefore prescribed as a standard. The outlines, however, of the parts in contact when coupled, as well as the sizes and distances of certain other parts are given, which should be followed within certain limits, irrespective of details of the coupling mechanism.

In Figs. 33 and 34 are shown the parts of the coupler which have been adopted as standard. *X X* is the contour line, which is composed of straight lines and arcs of circles, and only the parts in heavy lines are prescribed, the parts of the head back of this being left to the discretion of the designer, as they are not essential to the proper working of the coupler. Variations of $\frac{1}{16}$ and $\frac{3}{32}$ inch at different points are allowed on each side of this contour line, and gages have been devised, giving the limits which must not be exceeded, by means of which couplers and knuckles can be rapidly and accurately tested. The drawbar is 30 inches long from centre line of contact to the end. It is five inches square just back of the head, at *A A*, and has a horn, *B B*, projecting above the head, $8\frac{3}{4}$ inches from centre line of contact; at the rear end are provided rectangular lugs, *C C*, $5\frac{1}{2}$ inches long, 4 inches wide and $6\frac{1}{2}$ inches over the horizontal surfaces, to take a pocket strap. Two $1\frac{3}{16}$-inch holes are provided, located as shown, for bolting or riveting the strap to the bar by means of $1\frac{1}{8}$-inch

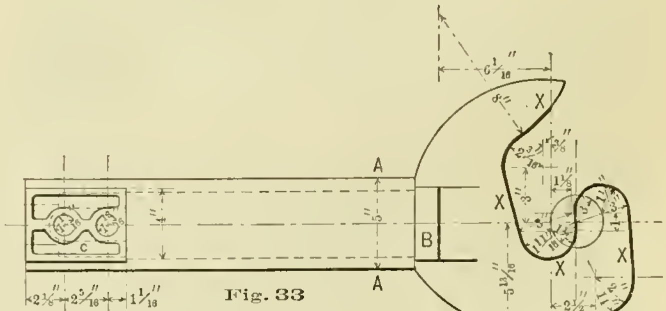


Fig. 33

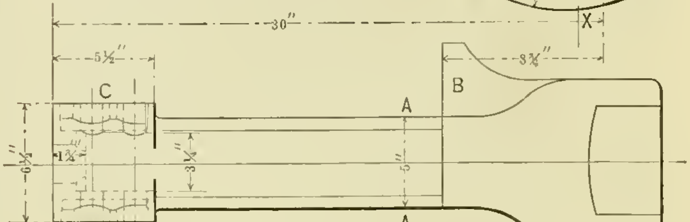


Fig. 34

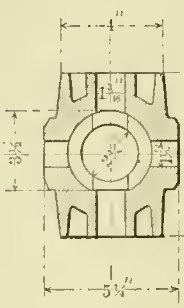


Fig. 35

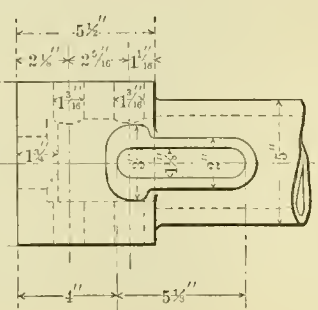


Fig. 36

the cars come together, and the pin must be dropped at the same time, before the impact separates the cars again. This performauce requires more or less bolts or rivets. A hole 2⅛ inches in diameter and 1¾ inches long is provided for a 2-inch tail pin, the drawbar being cored out with a 3½-inch hole, both the hole and the head of the pin resting in it being flattened on the bottom to keep the pin from turning. When the drawbar is used in connection with the continuous arrangement illustrated in the last article, the rear end shown in Figs. 35 and 36 is used, a horizontal slot for a 1 by 5-inch key being cast in it.

The number of different makes of couplers which conform to the M. B. C. standards is increasing constantly. and it would be out of the question to say that this or that oue is the best ; naturally the first ones in the market have beeu adopted by a number of roads, and are being applied to a great extent, but as competitiou has lowered the price, the newer ones are coming in for some share of the patronage. Elaborate tests have been made and specifications drawn up from time to time, to which drawbars should conform, but as yet no standards for strength or for the dimensions cf other points, excepting those mentioned, have been adopted. The question as to the best material for drawbars is still an open one, but malleable iron and steel are at present considered as really the only metals which should be used, and

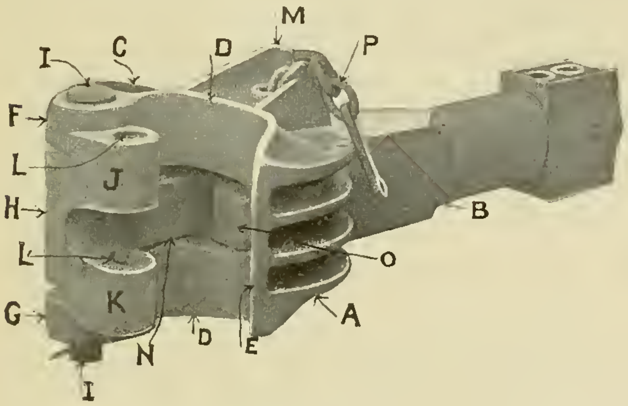


Fig. 37.

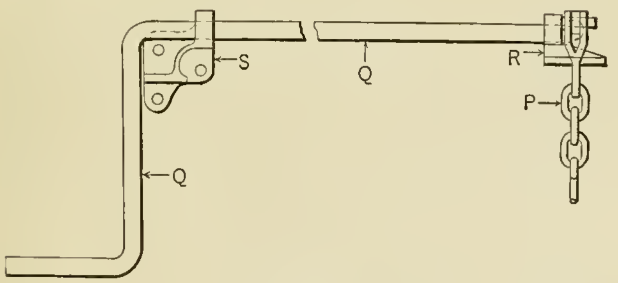


Fig. 38.

each has its numerous friends ; the tendency seems to be that drawbars will hereafter be made usually of malleable iron, and the knuckles will be steel castings, which is the practice of many makers at present. The other parts of the coupler are of minor importance and the material in them is generally governed by local conditions in design or manufacture.

Although all the various drawbars differ in the details, they agree in general principles in the more essential parts, aud these are shown in Figs. 37 and 38. The drawbar consists of the head, *A A*, and the shank *B B*. *C C* is the side wall of the head, *D D* the front face, *E E* the guard arm, *M M* the horn. Upper and lower lugs, *F F* and *G G* are provided, between which the knuckle, *H H* swings around the knuckle pin, *I I*. The knuckle has upper and lower lugs, *J J* and *K K*, leaving a slot which is used, when necessary to receive a link which is held by a coupling pin in the pin hole, *L L*. The knuckle terminates in the tongue, *N N*, which engages with the lock, *O O*; the latter is raised and lowered by a chain, *P P*, attached to the uncoupling shaft, *Q Q*, fastened to the end sill or end of car by brackets, *R R* and *S S*.

The principal difference in the various makes of couplers exists in the knuckle and locking arrangement. Many do not confine themselves to the simple lock, but introduce cams and springs. Knuckles are often arranged to open automatically when the lock is moved, some by means of a spring and some by means of gravity, inclined planes being introduced on the bottom of the knuckle and its bearing point on the head. The lock is usually held in place by gravity alone, and the use of springs for this purpose should be condemned.

Some couplers have been introduced which meet all the requirements of the law, in that they "couple automaticly by impact" with each other, but which are not at all like the standard of the M. C. B. Association, and will not couple with this class of coupler without the use of a link and pin, These couplers are no improvement in their most essential part over the old style of drawhead and are mentioned here only as being a good thing to avoid.

In order to be able to couple and uncouple cars without stepping between them the uncoupling rcd is extended to the side of the car as shown in Fig. 38. This rod is usually made of 1-inch round iron with an arm bent on it at the centre of the car extending over the coupler to which is attached the chain leading to the lock; the outer end is bent in the form of a crank handle, which when not in use hangs down on the face of end sill or end of car. To release the lock the handle is raised, and if dropped again, the lock will return to its former position; if the knuckle is open and is suddenly thrown back it will raise the lock, which then drops in front of the tongue and holds it in the closed position, until again released. The uncoupling shaft is now usually placed on the left side of the end of the car, the observer standing on the ground facing the end under consideration.

In the switching of cars it is sometimes desirable that the coupler of two adjacent cars be so arranged that they will not couple in case the cars should be moved closely together. This is attained by holding the uncoupling shaft in a position in which it will keep the lock out of action, the usual methods being to provide lugs or slots on one of the brackets in which the shaft works, which will keep the shaft in the desired position if lifted slightly or moved a short distance in the line of its axis.

One of the principal sources of trouble which developed with the introduction of the M. C. B. coupler was that on account of its size it formed quite a serious obstruction if by accident it was pulled out of the car and dropped on the track, and quite a number of wrecks have been caused in this way by the breaking of a tail pin or key. The substitution of the spring pocket for the tail pin on many roads has done away with the primary source of this difficulty, but on cars which still have the spindle other means must be introduced. It has been suggested that the claim of the unlocking device be made of such a length that should the coupler be pulled out an unusual amount it will raise the lock and thereby release the coupler from its adjacent one, preventing its being pulled out completely. An objection is raised to this plan in that the coupler is liable to be released when subjected to a sudden pull, even when there is no defect in the pin.

A device for holding up a coupler after it has been pulled out has been introduced in several modifications, the general principle being the fastening of a Z-shaped casting or forging to each coupler, just over or under the knuckle of the engaging coupler, on which the coupler which is pulled out will hang suspended.

Another means of preventing accidents by trains parting, either by drawbars uncoupling or pulling out, is that of safety chains, and the M. C. B. Association has considered these important enough to recommend a standard practice to be pursued in applying them. Safety chains on freight cars are, however, so little used, that it really seems like adopting the foreign hook-and-link coupling in addition to our own, which in itself should be sufficient, and the subject will not be further touched upon here.

(To be continued.)

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING..............................NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

ADVERTISING.
F. H. CLARKE, Morse Building, New York.
R. G. CHASE, 705 Western Union Building, Chicago.

JUNE, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

OUR NEW FORM.

At the time that the *American Engineer and Railroad Journal* was consolidated with the *National Car and Locomotive Builder*, owing to existing contracts for advertising, it was impossible to adopt the preferable size and form of the first named paper for the new publication. Since then negotiations with advertisers have made it practicable to change the size of page and general make-up of the paper to that which is presented to our readers in this number. It is hoped that it will commend itself to them, and it is the intention of its owner and editors in making the change to improve not only its form, but also the matter which it will contain, and it will be their aim to make its contents more interesting and valuable hereafter than they have ever been during any portion of the past sixty-four years of its existence.

The problem of the application of electricity to steam roads, as it now confronts managers of the latter interests, is neatly stated by the Massachusetts Railroad Commission, and will repay a careful reading. The question is one of economy. The mechanical and electrical questions have already been solved or are capable of solution without going too far into the field of the experimental. If a road can employ electricity in certain localities and thereby serve the public better, without loss to itself, it most certainly is justified in making the change, but if it adopts electricity in the hope of crushing the competition of suburban or inter-urban street-car lines and wresting from them a traffic which is naturally theirs, even if it has heretofore been conducted by the steam road, the move is one of doubtful wisdom. The steam roads need not fear outside competition for long-distance traffic, and if electricity ultimately becomes more economical than steam for the transportation of heavy trains over long distances, it will be adopted without the pressure of competition.

The paper on the effect of long pipe connections on indicator diagrams, published elsewhere in this issue, is worthy of more than passing notice. In it Professor Goss shows conclusively that the effect upon the area of the card is much greater than is usually supposed, and that for all ordinary work it causes the card to show a greater mean effective pressure than actually exists in the cylinder. It is probable that most of the indicator work in marine and stationary engine practice has not contained appreciable errors, because the connections have usually been quite short, but in locomotive practice few cards have been taken where the pipes were less than about three feet in length. Such cards may, therefore, be considered as too inaccurate to serve as the basis of very important deductions, though they may suffice for ordinary work. It would appear that what is now wanted is an indicator rig that can be applied to locomotives in which the pipe connections will be short enough to practically eliminate these errors. This is not easy, for large modern locomotives have so little clearance over the cylinder casings that a rig occupying any great space outside of the steam chest casings is in danger of being stripped off while the engine is running, and such a location of the indicator adds greatly to the danger to the operator. It is interesting to note that if the areas of cards taken at high speed are ten or more per cent. in excess of the actual mean effective pressure in the cylinders, train resistances, which already appear to be surprisingly low under such conditions, must be scaled down still further, thus making commonly accepted rules appear more inaccurate than ever.

PUMPS VS. COMPRESSORS FOR SHOP USE.

We had thought that everybody was convinced of the fact that air for shop use cannot be economically compressed in air-brake pumps, but if the May meeting of the Central Railroad Club is correctly reported in the Buffalo papers (and these reports are usually official), a committee submitted a report on air-brake testing plants in which they advocated the use of pumps instead of compressors on the score of economy, and in the discussion that followed, Mr. Higgins, of the Lehigh Valley, and Mr. McKenzie, of the Nickel Plate, were the only dissenting parties. Unfortunately for the committee, if their opinions are correctly quoted, it can easily be proven that it is economy to replace even a single pump with a compressor, and, in testing plants adjacent to shops where air can be used for other purposes also, thus requiring the capacity of several pumps, their use instead of compressors is extremely wasteful.

Comparisons between large steam-air compressors and pumps have been made in the past, but we are not aware that any attempt has been made to show the relative economy of pumps and small steam or belt compressors. For that reason it may be well to enquire into the matter. Two years ago the writer made some tests of 8-inch brake pumps in which it was found that for every pound of steam passing through the pumps there was on the average about 2.25 cubic feet of free air compressed to 70 pounds pressure. For every 1,000 cubic feet of air compressed there is therefore required 445 pounds of water, and if the evaporation of the boiler supplying the steam is taken at 8, the coal required is 55.6 pounds. The capacity of one 8-inch pump with 80 pounds of steam is about 1,000 cubic feet per hour, and if we assumed that the pump ran the equivalent of 10 hours per day for 300 days in a year the annual coal consumption is $55.6 \times 10 \times 300$, or 83 tons. As it is seldom that a single pump is of sufficient capacity for a yard or shop and as even the smallest belt compressors are usually of the capacity of two such pumps, we will first make a comparison on the basis of 2,000 cubic feet of free air compressed per hour, requiring two pumps consuming 166 tons of coal per year. It might here be remarked that as the speed of pumps vary considerably with slight differences of pressure, it may reasonably be urged that one pump might be made to do this work if higher steam-pressure were used; but if this is done the coal consumption is not altered materially, nearly the same amount of steam passing through one pump instead of two.

In considering compressors of small capacity those driven by belts must not be overlooked. We find by investigation that in this type about 2.8 horse power is required at the belt for each 1,000 cubic feet of air compressed per hour. If the shop engine consumes $3\frac{1}{2}$ pounds of coal per horse power per hour and the loss in transmission by shafting, belts, etc., is 40 per cent., the coal per horse power at the compressor becomes $3.5 \div .6 = 5.8$ pounds, and for compressing 2,000 cubic feet of air it is $2.8 \times 2 \times 5.8 = 32.4$ pounds. For a year of the same number of hours as before, the consumption is $32.4 \times 10 \times 300 = 48\frac{1}{2}$ tons.

In a steam compressor the horse-power per 1,000 cubic feet of air compressed, including the internal friction of the engine, we will take as 3.2, though it will vary somewhat with the construction of the compressor. In one having only 2,000 cubic feet capacity per hour a horse power cannot be expected on less than $4\frac{1}{2}$ pounds of coal with the evaporation we have assumed, and it might easily be more. Taking it at that figure the annual consumption would be $3.2 \times 2 \times 4.5 \times 10 \times 300 = 43$ tons.

Now a belt compressor of 2 000 cubic feet capacity per hour and provided with an automatic regulator or governor can be bought for from $200 to $250, and a steam compressor of that capacity will cost in the neighborhood of $350. Two brake pumps, even if they are not new, will represent an investment of from $100 to $200 according to their age. The comparison between the two types of compressors and the pumps might be summarized in tabular form thus:

	Value of investment.	Coal consumed in tons per annum.	Cost of fuel per annum at $1 per ton.	Saving per annum.	Saving capitalized at 6 per cent.
Two second-hand pumps.	$100	166 tons.	$166 50	....	....
One belt compressor	225	48½ "	48.50	$117	$1,958
One steam compressor.....	350	43 "	43	123	2,050

From the columns showing the annual saving and the same capitalized at 6 per cent., it will be seen that if the air-brake pumps were to be had for nothing it would still pay to buy the compressors if they cost less than $2,000. Perhaps a more striking way to view it is that if a road were offered two pumps and a bonus of $1,500 with them, their use to be confined to pumping air for shop use, it would be wise to refuse the offer and to purchase a compressor at market prices. If only one pump were needed it would still pay to buy a compressor of the size mentioned above, and the saving per year in fuel would still be more than $50.

We think the above figures are fair and not in the least exaggerated. If any one is disposed to quibble over some of the items, let him consider what the comparison would become according to his own figures if coal were at the same time taken at, say, $2.00 per ton, a price which many pay for it.

The figures seem to prove conclusively that though the air-brake pump is admirably adapted for the service which it was designed and is almost beyond criticism when on an engine, it is in the wrong place when compressing air for shop uses. If managers, purchasing agents, and others who wield the blue pencils that occasionally disfigure requisitions, could be made to realize these facts there would be more compressors purchased, for many officials in the mechanical departments who know the wastefulness of pumps cannot induce their managements to purchase compressors.

Before closing we might make a brief comparison between a compressor, with a capacity of about 18,000 cubic feet of free air per hour (a favorite size with some roads) and pumps of the same capacity. On the same basis as the previous comparisons, but assuming that the compressor can furnish a horse power on four pounds of coal, the annual fuel bill for the compressor would be $346 and of the pumps $1,500. This is not an ideal case, for we know of one company that had ten air pumps in its shops and now has in their place one large duplex compressor. The latter almost pays for itself in one year, with coal at only $1 per ton.

CAR WHEELS.

The notes on the Altoona shops, which will be found in another page, contain an account of some thermal tests and failures of cast-iron car wheels under the tests to which they were subjected, which probably add another cause of anxiety to the many which now haunt the minds of railroad men during their waking and probably sometimes their sleeping hours. It will also supply another argument to the makers and vendors of steel-tired wheels in favor of their wares, of which they will, doubtless, not be slow to avail themselves. In view of the experiments referred to, it may be said, interrogatively, that if a cast-iron wheel is cracked in a few seconds by contact with molten cast iron, how long will such wheels stand the application of brakes while descending a grade? It is true that cast-iron wheels are used less and less each year under passenger cars, and the Pennsylvania Railroad is one of the few great lines which still retains them in that branch of their traffic; but the company makes its own wheels, and, as was shown in the tests, those they make were not broken by the application of heat in the manner described. The danger to passenger trains is, however, not eliminated by confining the use of wheels which may be unsafe to freight trains alone. On all double-track roads there is always the possibility of terrible accidents if a wheel is broken under a freight train on a track adjoining another on which passenger trains run.

In view of this danger, it would be interesting to know whether the application of brakes, with the maximum pressure, when the wheels are revolving at their greatest speed, will have the same effect as the contact of melted cast iron had in the tests discovered. If so the inference cannot be escaped that wheels which will not stand such a test are dangerous.

Of course the steel-tired advocates will be prepared to show a ready way out of the difficulty, which will be the substitution of steel-tired wheels for those made of cast iron alone. But there are persons very competent to form an opinion on the subject, who contend that there are as many failures relatively of steel-tired wheels, as there are of those which are properly made of cast iron.

The figures contained in the last annual report of the British Board of Trade covering the year 1895 will have some bearing on this subject. For that year 454 failures of tires are reported in the United Kingdom. Of these it is said:

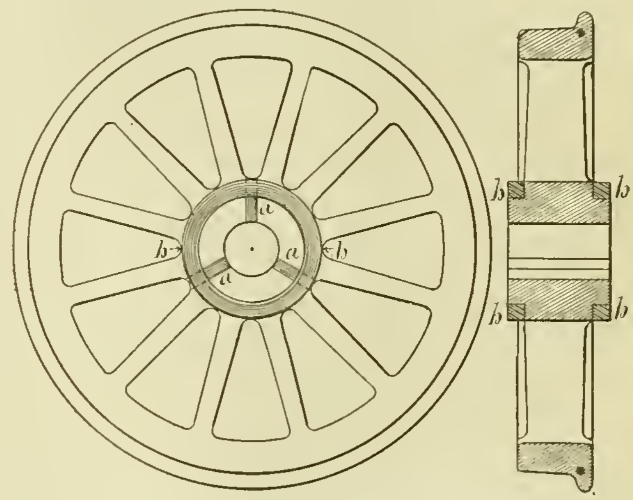
Twenty-one were engine tires, 8 were tender tires, 3 were coach tires, 17 were van tires and 405 were wagon tires; of the wagons, 309 belonged to owners other than railway companies; 268 tires were made of iron and 186 of steel; 12 of the tires were fastened to the wheel by Gibson's patent method; 11 by Mansell's patent method, 3 of which left their wheels when they failed; 3 by Beattie's patent method, 2 of which left their wheels when they failed; 91 by other methods, 50 of which left their wheels when they failed: 48 tires broke at the rivet holes, 1 in the weld, 154 in the solid, and 251 split longitudinally or bulged.

From these data it will be seen that the danger of breakage is not entirely removed by the adoption of steel-tired wheels, even when fastened with retaining rings; neither is it probable that steel-tired wheels will be generally substituted under our freight cars in the immediate future. It seems more likely—and it would appear to be a wise precaution—that railroad companies should specify that the wheels they use or buy should stand some such thermal test as has been described. The test has the advantage that if a wheel stands it it is not made useless thereby. It is not unreasonable, therefore, to expect that some railroad companies may require that several wheels in each 100 they receive shall be subjected to thermal tests, as well as to others which have heretofore been used. That it is possible to make wheels of the ordinary pattern—that is, with two curved plates next the hub and one inside of the rim and joined to the two inner ones, and with curved ribs or brackets in the back—which will stand the test was abundantly shown by the Altoona experiments. But, as is also pointed out in the notes, the experiments show clearly that all wheels are subjected to enormous strains when the rims or treads are heated. Probably the wheels which do not break when so tested are subjected to just as great strains, or at least deformations, as those are which fail, the only difference being that the material in some of them was capable of resisting such strains, whereas that in others was not.

In the design of the kind of wheels which were tested, the plates and the ribs are all made corrugated or curved, under a general impression that such forms will permit a slight amount of movement or deformation without rupture. That such forms are inefficacious in neutralizing the effects of expansion of the rims is indicated by the fracture of the wheels. In other words, those forms do not do what they were intended and were designed for. But is it not possible that some form could be designed which would permit the rims of wheels to be heated and expanded without causing a fracture? It is not easy to understand the nature of the strains which are produced in a wheel by heating its tread, nor how they cause it to fracture, transversely or radially. We have not heard of the experiment being made, but it would not be expected that a cast-iron tire would break transversely if its tread was heated by pouring melted cast iron around it, as was done in the wheel tests. It is proverbially dangerous to prophesy when a prophet is not sure of what will happen, and not having had the opportunity of making such an experiment, all that is asserted here is that we would not expect a cast-iron tire to break under such a test. Apparently what would occur, would be that the expansion would lengthen the ring of metal circumferentially and thus cause it to be enlarged in diameter. Now if we will imagine the inside of the tire to be tied to a central hub by an infinite number of fine radial wires in a state of tension—somewhat as the tire of a bicycle wheel is held—the expansion and consequent enlargement of the tire would apparently have a tendency to rupture the wires or break them by stretching. If the wires were strong enough to resist the tension caused by the expansion of the tire, then it would appear as though it would be subjected to a compressive strain in the direction of its circumference. Now, if instead of the wires we will imagine the tire cast solid on a central plate, as an ordinary wheel is made, then if the rim is heated the plate would be subjected to such radial strains as our hypothetical wires were assumed to resist, and it would again seem as though the rim would subjected to a circumferential strain of compression.

Or let it be imagined that a tire is fitted accurately to a cast-iron wheel center and is then heated. Obviously the effect will be to enlarge the tire diametrically and circumferentially and make it loose on its center. If it was cemented to the latter, apparently the effect of the expansion would be to break the cement or cause a circumferential fracture, which is what occurs where wheels are subjected to the thermal test described. What is not so plain is why the rim is broken transversely by heating it. If our wires, the cement between the tire or the center, or the plate were elastic, so that they could "give" radially, the strains which tend to break wheels circumferentially when their treads are heated would be relieved. The object of the corrugations in the plates and the curves in the ribs of ordinary wheels is to give this required elasticity. That these do not accomplish their purpose is shown by the tests which are here being commented on. What is needed seems to be greater radial elasticity or mobility in the plate of the wheel.

The generation of railroad men who are now playing the last act of their careers may remember how cast-iron wheels were made forty or fifty years ago. The following sketch, made from



memory, represents the kind which were made in what were considered large numbers by Ross Winans in his foundry in Baltimore.

As shown by the engraving, they were spoke wheels, the spokes being of rectangular section. The three shaded areas, *a*, *a*, *a*, in the hub were cored out, so that the hub of the casting was in three parts. Obviously this permitted the different parts of the wheel to expand and contract radially without straining any of them. After the wheel was cast, a steel drift, with a sharp cutting edge, was driven through the slots *a*, *a*, *a*, to remove the roughness of the castings. Wrought-iron plates were then driven in, and rings, *p*, *p*, were shrunk on the hub.

It seems as though a wheel made in that way would not be broken if tested in the manner herein described, which suggests the inquiry whether a form of wheel could not be designed which would have the same freedom to expand and contract that the Winans wheels had, and at the same time be without the obvious objections, which were inherent in that form of construction. It should be said here, that none of the parts of the hub of these wheels, excepting the bore, were machined. The shims *a*, *a*, *a*, rings *p*, *p*, and the bearings were all rough, and it was assumed would fit each other by some process of adaptation, which of course was very improbable. With modern appliances the openings *a*, *a*, *a*, could be slotted out, the outside of the hubs and inside of the rings *p*, *p*, could be turned with but little expense, and thus thoroughly good and reliable work could be done.

In the manufacture of these wheels Winans had considerable difficulty in getting sufficient chill in the throat of the flange, or where it joins the tread To obviate this difficulty, he placed a wrought-iron ring made of round iron one-half or five-eighth inch diameter, in the mould, as indicated by the blank circles in the section. These rings were first filed bright so that the molten iron would adhere to them, and then anchored in the mould before the casting was made. This method of manufacture was employed for some years, but was finally abandoned, we believe for the reason that the castings could not be made entirely sound in the vicinity of the rings.

Of course we are aware that numberless experiments have been made on cast-iron wheels, and that the number of forms which have been designed, proposed and patented is legion. Still improvement does not seem to be hopeless in this direction, as it is certain that the forms of wheel centers now used will not permit the parts to expand and contract without subjecting some of them to enormous strains.

At the Pittsburgh meeting of the American Institute of Mining Engineers, Mr. A. E. Outerbridge, Jr., of Philadelphia, read a very interesting paper with the title "The Mobility of Molecules on Cast Iron." In it he showed—on what seems to be conclusive proof—that under the influence of repeated shocks cast iron, instead of becoming brittle, as is ordinarily supposed, and weakened, has exactly the opposite effect produced by such treatment, and as a result of almost a thousand tests of bars of cast-iron of all grades, it was proved that it is materially strengthened by subjection to repeated shocks and blows. In view of the remarkable revelation which Mr. Outerbridge has made, it would be interesting to know whether cast-iron wheels which had been in service for a considerable time will stand the thermal test and other tests any better than new wheels do. It may be that eventually we will be obliged to subject such wheels to a sort of Swedish movement cure, or process of dynamic annealing, by subjecting them to a great number of repeated shocks in order to increase their strength. Those of an inventive turn of mind will readily conceive of a machine having a number of hammers acting radially, or in an axial direction to a wheel which would then be slowly revolved while it was subjected to an infinite or a great number of blows, to give the particles of the metal "mobility" and thus strengthen it and increase its capacity to resist thermal and other strains. In the language of patent specifications, "having thus fully described our invention, what we claim"—the reader can fill in.

THE VALUE OF A PATENT.

Our "esteemed contemporary," *Locomotive Engineering*, in its May issue, makes the following observations: "A patent has been obtained by Mr. M. N. Forney on a combination . . . of piston valve and cut-off, operated by a radial motion, which has a very close relationship to Joy's motion. We wish Mr. Forney much good luck out of his invention, but if he proposes to give a stock company the opportunity to boom the latest thing in valve-gear we must respectfully intimate that all our money is tied up."

That parties engaged in publishing two papers, one monthly and the other weekly should have "all their money tied up," is not a new phenomenon. In placing the stock of the new company, which our cotemporary intimates is about to be organized, none of it will therefore be assigned to the proprietors of the two papers, as other manufacturing enterprises seem to have absorbed all their spare cash, and they will thus lose the opportunity of "coming in on the ground floor." It has not yet been decided upon what basis the new patent will be capitalized, but due announcement will be made thereof. In the meanwhile we hope our cotemporary will not bear the market by detracting from the merits of the invention, and thus wrecking the company, which has not yet been formed. At present it is impossible to say "what there is in it for them," but if their silence cannot be secured in any other way, and as the senior editor of our cotemporary has had much secretarial experience, that position—without any salary—might be assigned to him as soon as a million of dollars of the stock is disposed of at par.

It is a curious fact that people without wit are apt to think that jokes are vulgar, and it is also true that men without ingenuity can seldom appreciate the value of a new and untried invention, which reminds us of a little story: Down in Pennsylvania a Dutch farmer had a dog which disturbed one of his neighbor's sheep. The neighbor shot the dog; whereupon suit was brought before a country "squire" by the owner to recover damages. When the case came up for a hearing the squire inquired—no pun intended—of the owner, with reference to the value of the dog. "Oh," the man replied, "he wasn't worth a dam. All I want is to make this man Fritz pay for him." Now it may be that the patent herein referred to is like the Dutchman's dog, and not worth a dam; but it is our infant, and we feel bound to defend it from such aspersions as our cotemporary has gently poured over it.

In the meanwhile, applicants for stock in the new company may address the Consulting Engineer of this paper.

TOLERANCE OF TOBACCO.

In the April issue of this paper we published an article which, to some extent, was an arraignment of the demerits of tobacco or the tobacco habit. Our "esteemed cotemporary," the *Railway Master Mechanic*, in an article on the same subject in the May number of that publication, dissents from the views which were advanced by us and which were then supported by much venerable authority. To the evil effects which were imputed to tobacco in our article, it seems, from our cotemporary's response, one more must be added, that of logical distortion, and it illustrates the truth of the Eastern proverb, that "reason is captive in the arms of the appetites as a weak man in the hands of an artful woman."

The writer referred to says the principal count in the indictment is that "tobacco is disagreeable to those who do not use it." In support of this, much testimony from wise, venerable and honored authorities was quoted. This our cotemporary discredits because the old worthies spelled execrably. Judged by this standard all wisdom which is more than a hundred years old must be discarded.

Our critic says that tobacco has the odor which the Lord gave it, and so has the onion, and therefore draws the inference that it is our duty to like both. The same observation will apply to the skunk. Our respondent says further that when persons are not endowed with a liking for such delectable perfumes that "the Lord makes up for the want by giving them other and special gifts and graces." Because woman don't like the smell of onions and tobacco she has been made good-looking. We are at present at a loss to know what is the special "gift" or "grace" with which our esteemed critic was endowed as a compensation for not enjoying the aroma of a pole-cat, whose perfume was nature's gift. It may be a source of satisfaction to beautiful women to know that they have been made so because they do not enjoy bad smells, but we would not advise our commentator to suggest to any of them such a reason for being good-looking, nor would it be judicious to solace any of the plain sisters by congratulations on their enjoyment of fetid odors.

He excuses the "universal and mighty craving" for tobacco by the fact that one "beautiful yearling deer, a few horses and some goats hanker after it." He adds further that the reason more beasts do not acquire the habit is that they have not the opportunity. In man only, he says, "the mighty instinct prevails." He should have spelled it *instinkt*, and then by inversion his argument concisely stated would be that the *instinkt* of smokers is stronger than that of beasts, which some of us are inclined to believe, but have not had the courage to state in its bald simplicity.

With reference to the Hottentot method of killing snakes by putting a drop of oil on their tongues, which our Chicago critic discredits, something should, perhaps, be said. Whether he suffers from snakes or not, we are not informed, but his familiarity with the methods of killing them is suggestive. We can assure him, however, that killing serpents by putting oil of tobacco on their tongues bears the same relation to the destruction of reptiles that the traditional salt deposited on their tails has to the catching of birds. We can assure him that if he is troubled with snakes, if he will only "catch them by the neck, force their jaws open and carefully deposit one drop of oil of tobacco on their tongues" and then live a sober and virtuous life, he will not be troubled with such varmints thereafter.

Our cotemporary sums up our argument by saying that we assume the attitude to others that "their tobacco is disagreeable to us, and, therefore, they ought not to use it." If he will modify this statement by the assertion that "when the use of tobacco is offensive to others no gentleman will indulge in the habit," we will accept the statement as being all that can reasonably be contended for.

NOTES.

On the Lake Shore & Michigan Southern Railroad much attention has been given for some time past to the proper loading of freight cars and freight trains. At large terminals, particularly Buffalo, extensive transfers of freight have been made, and cars partially loaded received from other roads have not been hauled in that condition if it is possible to avoid it. The same care has been exercised in the loading of engines, and the result of all this work and the co-operation of the various departments interested has been a gratifying increase in the average carload and in the average trainload. In the annual report of the company for 1895 it is stated that while the ton mileage for that year was the largest in the history of the company, being 12.73 per cent. greater in 1894, the freight train mileage was decreased 5.42 per cent. (from 8,218,912 miles in 1894 to 7,773,337 miles in 1895), and this in connection with an increase in the average freight-train load from 267.2 tons in 1894 to 318.5 tons in 1895, is one of the chief causes of the gratifying results in the net earnings as shown in the 1895 report.

A form of built-up crank axle has been adopted for some classes of locomotives by Mr. F. W. Webb, Chief Mechanical Engineer of the London & Northwestern Railway of England. The object is to get more effective crank pin surface for the main rods, this surface being ordinarily considerably narrowed by the radii at each end. In the built-up shaft the crank pins and driving-box journals are casehardened. The section of the axle between the cranks has the four eccentrics forged on it.

The Committee on subjects for the 1897 Convention of the Master Car Builders' Association are desirous that members send to the Chairman a list of one or more subjects, which will, in their opinion, be desirable for committee work during the coming year. The Committee also ask for suggestions of subjects for topical discussions for the noon hours during the 1896 convention. Replies are to be sent to A. M. Waitt, General Master Car Builder, Lake Shore & Michigan Southern Railway, Cleveland, O., not later than June 1, 1896, but we would suggest that members who have not complied with the Committee's request can write now or seek out the members at convention, and their suggestions, though late, will be welcome.

Electric drills have ceased to be a novelty, but certain progressive electrical engineers are not content with what has been accomplished in this inviting field. The ordinary brace and rachet drill is relegated to the small shop. In English shipyards, says Engineering Mechanics, the electric motor is suspended by a rope and pulley, which has a counterweight that admits of movement up and down by the workmen. By easily-controlled mechanism the motor is steadied, and the drill can be worked 200 to 300 revolutions, but 70 to 100 is the average. The most ingenious device for driving drilling tools bores a series of holes one after another. In the electric drilling motor, as developed in some yards, each of its three legs is now an independent magnet, having a positive and negative pole. The face of each leg has three concentric spaces. The inner circle composes the negative pole, the outer ring the positive pole, a concentric portion between the two being filled with insulating material. Thus a perfectly steady tripod is afforded, and there is no danger of the drill breaking by its cutting unevenly through the plate. All these processes are as yet practically in their infancy, but it would seem as though the electric drill had a most important future. The system might be extended, with the aid of the tripod electro-magnetic contact, to slotting and planing, and we have little doubt that this will yet be accomplished. Messrs. Siemens have constructed portable electric motors, running at various speeds from 900 to 1,200 revolutions per minute; these motors being connected up to long flexible cables, associated with a powerful current from a dynamo, and being capable of rapid application to a vertical drill, which can be worked in any position within the radius provided by the length of the cables, and moved about from spot to spot as required.

As demonstrating the stability of lofty office buildings, the *Scientific American* quotes the results of a test recently carried out on the twenty-first floor of the American Surety Building, Broadway, New York, by the engineer and superintendent of the building, Mr. J. Turner. It was made during the height of a heavy storm which prevailed Jan. 4, when an official wind velocity of 82 miles per hour was registered in the neighboring station. The test failed to give the slighest evidence of vibration ; a result which agrees with the testimony of the inmates that in a gale the topmost floors are as still as the first stories. The test was made with transit and level, and though it was not a test of the highest instrumental character, the result was remarkable, for both the plumb bob and the bubble remained perfectly still, even when the building was struck by the heavier gusts of wind.

In 1894 the jury of the section of Mechanical Industries at the Bordeaux Exhibition requested a test of the consumption of a Laval steam turbine of 100 horse power. Arrangements were made to measure the steam fed from a separate boiler, and two tests were carried out, one at the normal power of 98 horse power, the other at half load, 49 horse power. The consumption of steam was, working condensing: At full load, 32.23 pounds per kilowatt, 23.71 pounds per electric horse power, 20.15 pounds per brake horse power ; at half load, 40.30 pounds per kilowatt, 29.65 pounds per electric horse power, 23.80 pounds per brake horse power. The efficiency of the dynamo used was taken at 85 per cent. at full and 80 per cent. at half load. A supplementary trial in the workshops of Messrs. Brégueton on a 74-horse power Laval steam turbine for electric lighting was also made. The steam consumption was measured by means of a surface condenser ; and in a second trial, with a condenser giving a better vacuum. The object was to show that whatever the vacuum, the consumption, without reference to the work done, remains the same. The first trial lasted three hours. The vacuum was 21.6 inches for the first two hours, and 17.7 during the third ; the steam consumption did not vary. In the second trial the vacuum was 25 inches, and the consumption of steam 32.47 pounds per kilowatt. These results prove that the quantity of steam used depends only on the steam pressure and the section of the pipe, and not to the exhaust pressure. If a steam turbine is meant to work economically with a small load, it is necessary to adjust the section of the orifice, and not the pressure of the steam by throttling. This is confirmed by an experiment made on a 10-horse power Laval steam turbine, without condensation, by Mr. Vincotte, Manager of the Belgian Steam Boiler Association. The consumption was 49.2 pounds at 9.7 horse power, and rose to 59.4 pounds at 6.5 horse power, and to 89 pounds at 3.31 horse power ; by throttling the admission valve the pressure of the steam was very much reduced on entering the turbine.—*Inst. Civil Engineers—Foreign Abstracts.*

The Lehigh Valley Railroad Company put in service May 18 two trains of elegantly equipped cars for service between New York and Buffalo, which for completeness of detail and for comfort and safety are said to be unexcelled. These trains are to run daily, except Sunday, leaving New York and Buffalo, respectively, about noon, making fast time, and enabling those using the train to devote part of the day to business before the hour of departure, and at the same time offering an opportunity for viewing the scenery for which the Lehigh Valley Railroad is celebrated. The trains consist of a combination baggage, cafe and dining car coaches and an observation and parlor car, one of the features of the latter being a room for ladies, containing lounges, writing tables and easy chairs, with a library of current literature, together with the daily and weekly papers and magazines. Corresponding accommodations for men are found in the combination car, which contains a cafe, library, writing and smoking room. Some time ago General Passenger Agent Chas. S. Lee offered a reward of $25 in gold to the successful competitor who would suggest a name that should be finally adopted. The name chosen is the "Black Diamond Express," and C. M. Montgomery, of Toledo, O., gets the $25.

The steadily increasing business of the Boston & Maine Railroad has necessitated increased shop facilities and a tract of several acres has been purchased just south of the business section of Concord, N. H., where it is the intention to erect shops at once. The plans of the company have not been made public, but it has been surmised that the new shops will be adapted not only for repair work, but also for the construction of cars and locomotives, a line of work not heretofore attempted on this road. The shops at Salem and Lawrence are to be retained.

Some of our readers may be interested in the details of the Sweeney brake, which is designed to utilize the cylinders of the locomotive as air pumps to fill the main reservoir of the brake system when the train is on a heavy grade. The details are few and simple. A 1¼-inch pipe is tapped into the steam chest cover and just outside of the casing a 1¼-inch plug cock is placed in the pipe. The pipe leads to the main reservoir and the plug cock is operated from the cab by a small rod and lever. Near the plug cock a 1¼-inch pop-valve is inserted in the pipe to prevent excessive pressure, and near the main reservoir a 1¼-inch non-return check valve is placed in the pipe to prevent air going out of the reservoir through this pipe. This comprises the whole apparatus. It has been reported upon very favorably by those using it in mountainous districts.

On the Union Pacific considerable trouble has been experienced with leaky joints in steam pipes in smokeboxes, and it is believed to be due in part to the thickness of the pipes. With a view of overcoming this trouble, Mr. McConnell has ordered a number of malleable iron pipes, the walls of which will be much thinner. The cast-iron pipes weigh 273 pounds, and the malleable iron ones weigh 148 pounds. The cost of the latter will be about the same as the former, the higher price per pound being offset by the lesser weight.

In a paper read before the Institution of Civil Engineers on the thermal efficiency of steam engines, Capt. H. R. Sankey advocated the comparison of engine performances with a standard thermal efficiency. He proposed as a standard the performance of an ideal engine, whose indicator diagram would be as follows: (1) Admission line at the temperature of the steam at the stop-valve of the engine; (2) expansion line adiabatic, and carried to within 0.15 atmosphere of the back pressure; (3) back pressure: that in the exhaust immediately outside the engine; (4) compression *nil*, and clearance *nil*. The object of limiting the expansion by carrying it down to within 0.15 atmosphere of the actual back pressure, instead of all the way down to the back pressure line, was to avoid encouraging the construction of engines too large for their work; if, on the other hand, the expansion in the standard were only carried to a pressure equal to the back pressure plus the mean pressure, corresponding with the fricton of the actual engine, a premium was, so to speak, awarded to the engine with large internal friction, and the standard would be made to vary with the friction of the actual engine. To avoid the lengthy calculation of the absolute thermal efficiency of the proposed standard, curves had been prepared enabling the required result to be obtained by inspection, and numerical examples were given to show the method of application.

The *Engineer* says: A well-known Middlesboro firm of iron merchants has just imported a quantity of pig iron from Alabama. It has, however, been brought over on very exceptional terms, the freight being little more than a merely nominal figure, as the iron was put in as stiffening to a cotton steamer. In the ordinary course the freight would prevent the importation of such iron except at a considerable loss. If the experience of another Middlesboro merchant firm is any criterion, this iron is not likely to be taken up by founders. The firm referred to last year imported some Alabama pig, and it is still on their hands in Liverpool, except a few sample lots. Consumers on this side have not taken kindly to it, as they say it does not suit their purposes.

Though the shops of the Delaware, Lackawanna & Western at Scranton have enough repair work to heavily tax their facilities, Mr. McKenna, the Master Car Builder, has managed to build thus far this year, sixteen new milk cars, two coaches and one mail car. The magnitude of the milk traffic on the road may be judged from the fact that the company has 111 cars devoted to this business. All passenger cars that are overhauled are fitted with vestibules and Gould platforms. If the cars are for through trains the vestibules are provided with side doors, but for local traffic they are omitted. For their through trains between New York and Buffalo the company is putting buffets in four coaches, one for each train, and the urns will be heated with Pintsch gas taken from the reservoirs under the cars. The same use of gas is made on the Wabash and New York, New Haven & Hartford roads.

The Lachine Rapids of the St. Lawrence are about to be utilized. For some time past work has been prosecuted on a large wing dam which runs out for more than 1,000 feet into the St. Lawrence River. A fall of water is secured by means of this dam, sufficient to develop at the low-water season about 15,000 horse-power. This water-power is to be transformed into electricity. Upon the dam a power-house will be built, which will run its entire length and show an unbroken interior of 1,000 feet in length. The basement of this will be occupied by water wheels. The main floor will contain the dynamos, of which there will be 12, each of 1,000 horse-power, or 12,000 horse-power in all. They will generate currents for transmission to Montreal for use there in lighting the city, operating the street railroads, and for any and all other lighting and power purposes.

A correspondent of the *English Mechanic* gives the following direction for oxidizing and blacking the bright work of steel in lieu of paint, to stand heat and to wear well: "Take 3 ounces of glacial acetic acid, mix it with its weight of water, to this add ½ ounce of powdered nut galls, and let stand for a day or two, shaking it up occasionally. Then let settle; then pour off the clear, then put a pint of boiling water to the residue. When cold and settled, pour off the clear and mix with the first. Now to this add a grain of nitrate of silver or sulphate of copper or nitrate of copper. Dissolve whichever you use in a little hot water before mixing with the other liquid. Silver is the best process. Clean all oil off and rust or scabs, paint, etc. Clean all up bright with pumice-stone powder. Don't use emery in any form, but the above with a piece of wood. Then clean all off; dry with air-slaked lime. Now go over it with the liquid with some cotton wool. If you have saved your powdered galls, take a little of that upon your wool, and will find that a great acquisition in the first application. Let stand until dry; then give it another coat. When dry, scratchbrush it, and give it another coat, etc. When you have got it to your liking, give it some linseed-oil and camphor. All bright iron parts can be made like ebony polished, and with the gun-metal mounting you will have a picture in black and gold. Cylinder covers, etc., can be done the same; but you must wash with hot water before oiling it. It will stand any amount of heat, the hammer and friction in wiping; you have no blistering, and you will have some difficulty in eradicating it. Bicycles, repairs, handle-bars, etc., can be treated the same way to advantage, well washed with hot water; when dry give them a coat of good copal carriage varnish."

A correspondent of the *Scientific American*, writing on raising of the lake levels, says there is much speculation over the utility of dams at the mouth of Lake Ontario and other lakes, but the plan will hardly be tried till something arises to make it appear feasible. It appears that the evidence is now to be had. The first vessel left Buffalo this season on April 20. There was at the time about 80 miles of ice to pass through before reaching open water. This ice disappears mainly through the action of the sun, but during the week, or perhaps fortnight, taken for it to disappear, large masses of it become detached and pass down the river. Naturally, this ice occasionally strikes the rocks at the head of the river, as the water is shallow, where it forms an imperfect dam. For some time the vessel men in the harbor noticed that the depth of water was subject to sudden variations.

An observation of the water line on the docks would show a rise or a fall of a foot or more in an hour or so. These changes were carefully observed now for the first time, as there was so much more dependent on the depth of water than usual at this time of year. The water level is materially affected by the wind, but there were changes of level that took place with no corresponding change of the wind, and it was at length found that whenever the ice field escaping into the river was caught on the shoal at the head of it the water rapidly rose and the vessels aground inside the harbor could be released. The main point of the showing seems to be the effectiveness of so frail and irregular a barrier as that formed by the ice, and, after that, the rapid rise of the water. But for the destructive force of storms and the flow of ice in spring, the showing is sufficient to prove that the dumping of ordinary stones, such as are constantly obtained from marine rock blasting, might be sufficient to solve the problem ; and it is considered quite possible that these loose stones would remain several years without any cement or anchorage to hold them.

The conclusion reached by the correspondent from this action of the ice is that the proposed dams need not be nearly as complete and expensive as was supposed and that they will produce the desired result.

An enormous landslide occurred in the Himalaya Mountains on the northwestern frontier of BritishIndia in 1893, and, by damming up one of the tributaries of the Ganges, formed a lake which threatened great damage to the valley below when it should overflow. The mountain from which the slide occurred is 11,000 feet high, and the material came from a point 4,000 feet above the bed of the stream. The size of the barrier may be judged from the fact that it was 900 feet high, 3,000 feet long across the gorge on top, 600 feet long on bottom, and in cross-section was 2,000 feet at the top, and 11,000 feet at the bottom. The Government took in hand the task of reducing to a minimum the damage from the coming flood. Engineers surveyed the locality and determined by calculation the time when the lake would overflow, fixing a date that afterward proved to be within 10 days of the actual time. Telegraph stations were erected and maintained to warn the people in the valley and piers set in the hill sides 200 feet up from the stream to show them how far they must go to be safe. Other precautions were taken, such as removing steel suspension bridges and substituting temporary rope and wooden structures for them, and carrying out protective measures for the head works of a canal some 150 miles away. Various preparations were made for observations of the yielding of the dam, but it broke during the night (11:30 p. m.), when a heavy fog obscured everything, and by morning the level of the lake had fallen 390 feet. It is calculated that 10,000 million cubic feet of water was discharged in 4½ hours. In an account of the flood *Engineer* says that at the gorge immediately below the dam the flood rose to 260 feet over its ordinary level. The valley was filled up with huge blocks, and the bed of the river was raised some 234 feet, by a substantial weir with a long gentle slope stretching far down the valley. At 13 miles down, the river bed was raised 50 feet by the *debris* deposited, and the flood reached a height of 160 feet above its ordinary level. All down the valley, for fifty odd miles, the flood rose from 113 feet to 140 feet, causing serious damage. Even at Shrinugar, 72 miles from the landslip, the flood, which was first observed at 3:25 a. m., attained a maximum height of 42 feet above ordinary flood level. Here the damage done was great. The flood reached Hardwar, 150 miles from Gohna, at 8:45 a. m., on Aug. 26, and obtained a maximum height of 11 feet above the ordinary flood level. Fortunately, the main river was low at the time—lower, in fact, than at any time during the previous month. Had the extra Gohna flood arrived on top of one of the very heavy normal floods of the previous 30 days, the canal must have suffered grave disaster. As it was, considerable damage was done.

No lives were lost anywhere in the valley, excepting those of a fakir and his family who had twice been forcibly removed from his hut immediately under the dam and who persisted in returning to it. The self-imposed task of the Government cost it Rs.2,500,000.

The *Steamship* in its May number, in commenting on the increasing prosperity of the English shipyards, has the following to say about the shipping of other countries : France has made great efforts to encourage shipbuilding by granting bounties, but the result is a marked failure. She pays about £500,000 in bounties to shipping. Germany grants even more than this, but in her case the result is that her shipbuilding is being rapidly extended. At the present time all the yards in Germany are full of orders. Her merchant tonnage is now 1,300,000 tons, which is about double what it was ten years ago. Russia spends over £250,000 in shipping subsidies; her fleet is steadily increasing, but most of the ships are built in Great Britain. Italy pays over £100,000 in bounties, but her shipping and shipbuilding are declining. The United States is making headway in shipping and shipbuilding, and the Government is taking steps to foster the industry. The annual statistics of the Bureau Veritas relating to the mercantile navy of the world give the total number of sailing vessels now afloat, measuring over 50 tons, as 25,570, with an aggregate tonnage of 9,323,995 tons. Of this number, Great Britain comes first with 8,793 ships of 3,333,607 tons. The United States is second, with 3,824 vessels and 1,362,317 tons. Norway is third, with nearly one thousand fewer vessels than the United States, but nearly the same amount of tonnage. In regard to the steamers, England counts 5,771 vessels, with nearly ten million tons. Germany, which comes second, has 826 steamers of 1,306,771 tons. France comes third, with 501 steamers and 864,598 tons. The United States holds fourth place, with 447 steamers and 703,399 tons. These figures relate only to ocean and seagoing vessels, and do not include coasting craft or those employed in lake and inland navigation.

The Effect upon the Diagrams of Long Pipe-Connections for Steam Engine Indicators.*

BY PROF. W. F. M. GOSS.

Errors in indicator diagrams may arise from several causes, one of which is the pipe connecting the indicator with the engine cylinder. It is admitted that, under the conditions of ordinary practice, the presence of the pipe does not constitute the most prolific source of error, but it can be shown that it does cause serious distortion in the form of the diagram, and it is believed that this fact merits more careful consideration than has heretofore been accorded to it. The writer has already called attention to the fact that in road tests of locomotives, where the indicator is attached to a length of pipe sufficient to bring the instrument to the top of the valve box (a length of 3½ feet or more), a true card can be obtained only at slow speeds; and has shown that, for a speed of 300 revolutions per minute, the diagram is likely to be in error as much as 17 per cent.† These early experiments were further used as the basis of a discussion concerning the precise character of the influence exerted by the pipe. They have now been followed by a more extended series of experiments, the results of which are herewith presented.

All experiments were made in connection with a 7¾-inch by 15-inch Buckeye engine. The power of this engine was absorbed by an automatic friction brake, by means of which a very constant load was obtained. The head end of the engine cylinder was tapped with two holes (*a* and *b*, Fig. 1), both in the same cross section, and hence equally exposed to the action of the steam in this end of the cylinder. One of these holes (*a*) was made to serve for the indicator *A*, the cock of which was placed as close to the cylinder as possible. The hole *b* was made to receive one end of a U-shaped pipe, the other end of which entered a coupling fixed in the angle plate *c*. The cock of a second indicator, *B*, was screwed to this coupling. A single system of levers supplied the drum motion for both indicators. The closely-connected indicator, *A*, will hereafter be referred to as the "cylinder-indicator," and the cards obtained from it as "cylinder cards." It is assumed that this indicator recorded the actual conditions of pressure existing in the cylinder. In like manner the indicator *B* will be referred to as the "pipe-indicator," and cards obtained from it as "pipe-cards." It is assumed that this indicator gave a record which, when compared with that given by the cylinder indicator, demonstrated the effect of the pipe.

* Abstract of a paper read at the St. Louis meeting of the Amer. Soc. of Mech. Engineers.
† Proceedings of Western Railway Club, March, 1894, page 257.

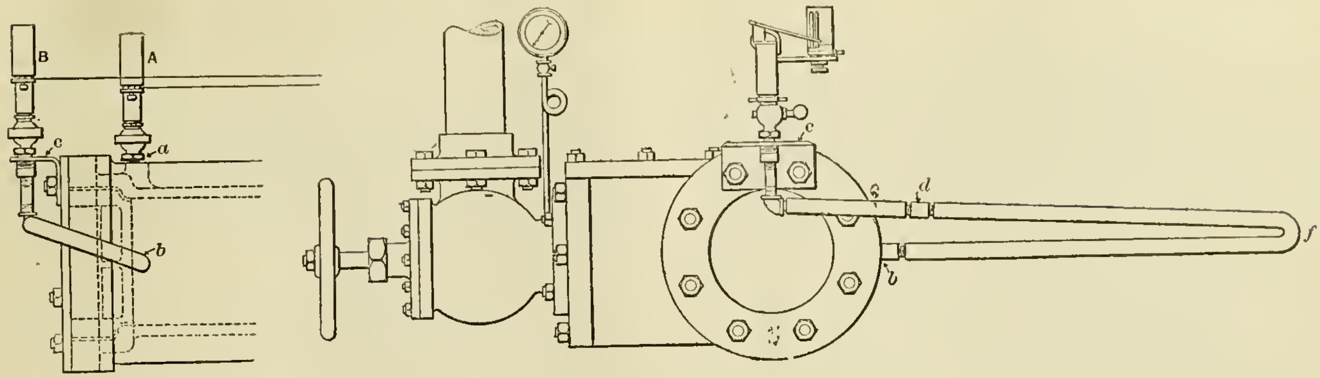


Fig. 1.—Method of Attaching Indicators.

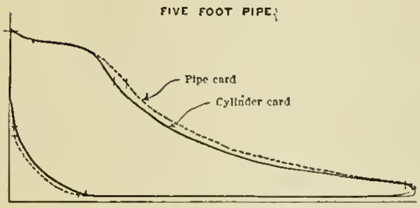


Fig. 2.

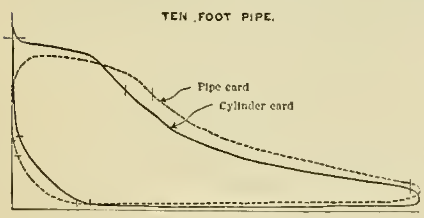


Fig. 3.

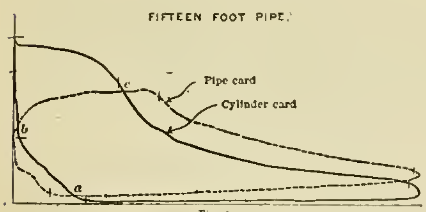


Fig. 4.

The speed (200 revolutions per minute), the steam pressure (80 pounds) and the cut-off (approximately ¼ stroke), were constant for above diagrams.

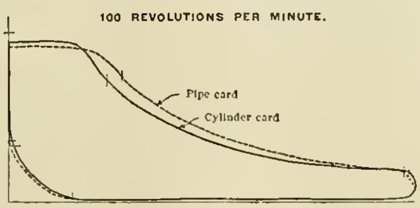


Fig. 6

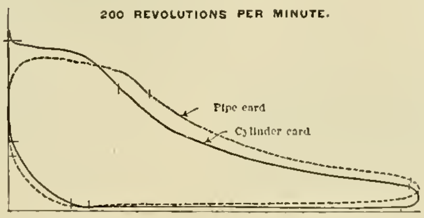


Fig. 7.

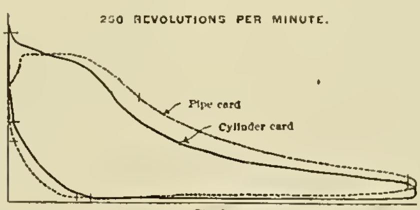


Fig. 8.

The steam pressure (80 pounds), the length of pipe (10 feet) and the cut-off (approximately ¼ stroke), were constant for above diagrams.

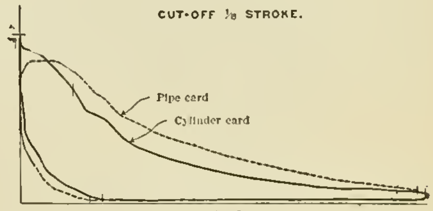


Fig. 9.

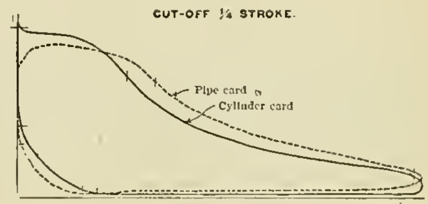


Fig. 10.

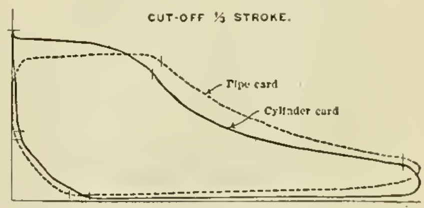


Fig. 11.

The cut off as given above is approximate. The steam pressure (80 pounds), the speed (200 revolutions per minute) and the length of pipe (10 feet) were constant for above diagrams.

Comparison Between Pipe and Cylinder Cards at Various Speeds and Cut-Offs.

The pipe fittings were all half-inch. A right-and-left coupling at *d* allowed the U-shaped section *d f b* to be removed at will and replaced by a similar section of different length. Pipe lengths of 5, 10 and 15 feet were used, length being measured from the outside of the cylinder wall to the end of the coupling under the cock of the pipe-indicator. The pipe and fittings were covered first with a wrapping of asbestos board, next with three-eighths of an inch of hair felt, and finally with an outside wrapping of cloth. It is to be noted that the bend in the pipe at *f* is easy, and that there is a continual rise in the pipe in its course from the cylinder to the indicator. New Crosby indicators were used and were always well warmed before cards were taken.

The results, which are presented in the form of diagrams (Figs. 2, 3, 4, etc.), were obtained in the following manner:

The engine having been run for a considerable period, and the desired conditions as to pressure, speed and cut-off having been obtained, cards were taken simultaneously from the cylinder and the pipe-indicator. Two pairs of cards (*i. e.*, two from cylinder and two from pipe) were thus taken as rapidly as convenient, after which the position of the indicators was reversed, and the work repeated. There were thus obtained four cylinder-cards and four pipe-cards, one-half of each set having been made by one of the indicators, and one-half by the other. Next, by the use of closely drawn ordinates the eight cylinder-cards were averaged and combined in the form of a single card, and the eight pipe-cards were in the same way combined to form a single pipe-card. The two typical cards thus obtained, superimposed as in Fig. 2, constituted the record of the test. This process was repeated for each of the several conditions under which tests were made. It is proper to add that the accuracy of the indicators used, and the constancy of the conditions maintained, were such as to make each card almost, if not quite, the exact duplicate of the representative of its set.

The diagrams presented are two-thirds size, the spring for all being 60 pounds.

ANALYSIS OF RESULTS.

Different Lengths of Pipe.—The effects produced by the use of pipes between the indicator and the engine cylinder, of five, ten and fifteen feet in length, are shown in Figs. 2, 3 and 4 respectively, the speed, steam pressure and cut-off being constant.

By reference first to Fig. 2, it will be seen that the effect of a five-foot pipe is to make the indicator attached to it a little tardy in its action. Thus, during exhaust, when for a considerable interval of time the change of pressure to be recorded is slight, the lines from the two indicators agree; but during the compression which follows the loss of sensitiveness in the pipe-indicator is made evident by its giving a line which falls below the corresponding line traced by the cylinder-indicator. Similarly, during admission there is an approximate agreement, while during the expansion which follows the lagging of the pipe-indicator results in a line which is higher than the expansion line given by the cylinder-indicator. As a result of this lagging in the action of the pipe-indicator, its card is in error in the location and curvature of the expansion and compression curves; also in the location of the events of the stroke and in the area which it presents. The speed at which these errors are shown to occur is moderate (200 revolutions), and the length of pipe attached to the indicator is not greater than is often used.

The general effect of a 10-foot length of pipe (Fig. 3) is the same with that of the shorter length, but the lagging action due to the pipe is more pronounced, and all errors are proportionately greater. The total range of pressure recorded upon the cards is less than the range existing in the cylinder.

A still further addition to the length of the pipe brings changes (Fig. 4) into the form of the pipe-card diagram which, while entirely in harmony with those already discussed, are of such magnitude that the form of the card loses some of its characteristic features. The admission and expansion lines are lower, and the exhaust line is higher, than are the corresponding lines for the true card. Furthermore, while cards from pipes of five and ten feet in length present an area greater than that of the true card, the card from a 15-foot length of pipe makes the area less. It is evident that a pipe of suitable length would result in a diagram somewhat similar in form to that shown by Fig. 5; a pipe still longer would give a card which would be represented by a single line, as *AB*, Fig. 5.

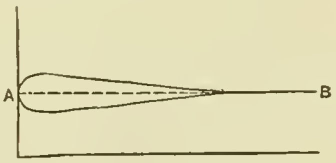


Fig. 5

It is true that the lengths of some of the pipes experimented with are excessive as compared with those commonly used for the connection of indicators, but this fact does not deprive the results of their significance. If pipes of fifteen, ten and five feet in length will produce the effects shown by Figs. 4, 3 and 2, respectively, it is but reasonable to suppose that pipes of less than five feet in length will produce some effect. And, since the effect of a five-foot pipe is considerable, this length must be greatly reduced before the effect ceases to be measurable.

[The author next explains the cause of the slight differences in form between the cylinder diagrams taken under the same conditions. These are attributed to changes in clearance produced by the different lengths of pipes leading to the other indicator, the greater surfaces exposed to the steam in the longer pipes, and to the flow of steam in and out of these pipes. He concludes that the existence of these differences in the cylinder diagrams does not in any way affect the results the paper is designed to present. Each cylinder card is true for the conditions under which it was taken.]

The Effect of the Pipe at Different Speeds.—The effects thus far discussed are those recorded for a constant speed of 200 revolutions per minute. In considering to what extent changes of speed will modify these results, reference should be made to Figs. 6, 7 and 8, which give a series of results for which all conditions were constant except that of speed. It will be seen that increase of speed produces modifications in the form of the pipe-diagrams which, in kind, are similar to those produced at constant speed by increasing the length of the pipe, but these changes are not great. For example, increasing the speed from 100 to 200 revolutions per minute (Figs. 6 and 7) produces less change than increasing the length of the pipe from 5 to 10 feet (Figs. 2 and 3). The fact that an engine runs slowly, therefore, does not seem to justify the use of an indicator at the end of a considerable length of pipe. Slow running reduces the error; it cannot be depended upon to eliminate it entirely.

The Effect of the Pipe at Different Cut-Offs.—The relative effect of the pipe at different cut-offs, other conditions being constant, is shown by Figs. 9, 10 and 11. It will be seen that the differences of pressure recorded during expansion by the two indicators (pipe and cylinder) are approximately the same for all cut-offs; but the relative effect of these differences upon the area of the diagram is most pronounced upon the smallest, or shortest, cut-off card. The fact that in Fig. 11 the steam line on the pipe-card rises while that of the cylinder-card declines, constitutes a good illustration of the slowness with which the pressure in the pipe responds to that in the cylinder. The following conclusions constitute a summary of the data already presented:

1. If an indicator is to be relied upon to give a true record of the varying pressures and volumes within an engine cylinder, its connection therewith must be direct and very short.
2. Any pipe connection between an indicator and an engine cylinder is likely to affect the action of the indicator; under ordinary conditions of speed and pressure, a very short length of pipe may produce a measurable effect in the diagram, and a length of three feet or more may be sufficient to render the cards valueless except for rough or approximate work.
3. In general, the effect of the pipe is to retard the pencil action of the indicator attached to it.
4. Other conditions being equal, the effects produced by a pipe between an indicator and an engine cylinder become more pronounced as the speed of the engine is increased.
5. Modifications in the form of the diagram resulting from the presence of a pipe are proportionally greater for short cut-off cards than for those of longer cut-off, other things being equal.
6. Events of the stroke (cut-off, release, beginning of compression) are recorded, by an indicator attached to a pipe, later than the actual occurrence of the events in the cylinder.
7. As recorded by an indicator attached to a pipe, pressures during the greater part of expansion are higher, and during compression are lower, than the actual pressures existing in the cylinder.
8. The area of diagrams made by an indicator attached to a pipe may be greater or less than the area of the true card, depending upon the length of the pipe; for lengths such as are ordinarily used, the area of the pipe cards will be greater than that of the true cards.
9. Within limits, the indicated power of the engine is increased by increasing the length of the indicator pipe.
10. Conclusions concerning the character of the expansion or compression curves, or concerning changes in the quality of the mixture in the cylinder during expansion or compression, are unreliable when based upon cards obtained from indicators attached to the cylinder through the medium of a pipe, even though the pipe is short.

Bechem & Post's System of Water-Spray Firing.*

BY ADOLPH BECHEM.

A water-spray ventilator, manufactured by Mr. F. Kluge, of Barmen, having been adapted to a soldering stove, it was observed that the fire became so fierce that a soldering-tool placed in it speedily became partially melted. The draught in the case of a smith's forge provided with this spray-ventilator produced a much greater heating effect than had previously been obtained by means of a Root's blower with a manometric pressure equal to 15.7 inches of water; the equivalent draught with the water-spray ventilator being only 0.12 inch. The author was led, on this account, to attribute the rise in temperature to the decomposition of the minute globules of water and the combustion of the resultant gases. He accordingly purchased Mr. Kluge's patent for firing purposes. Attention is directed to the various ways in which water can be employed as fuel and its use in the production of so-called water gas. When utilized as steam in the form of the steam-jet, water is much less effective as fuel in consequence of the fact that one molecule of water occupies the space of 1,700 molecules of steam, and thus the chemical energy of steam is only the $\frac{1}{1700}$ part of that of water. The peculiar value of the water-spray as fuel lies in the fact that the finely divided drops of water come into far more intimate contact with the carbon on the hearth than the more elastic particles of steam and, moreover, as air is needed to support combustion, and as steam is at even temperatures specifically much lighter than air, there is, in the case of the steam-jet, a tendency on the part of the steam to separate itself from the atmospheric air, to rush forward to the fuel, and to prevent the free access of air to the carbon. Experiments with various kinds of fuel—coal, coke, etc.—in a smith's forge, have demonstrated that the water-spray is capable of producing the highest possible temperatures; the special arrangement of the jet for this purpose are explained. The use of the water-spray under fire-bars is extremely beneficial, as they are thereby kept cool and become rapidly protected by a coating of oxide, which serves as a preservative; there is, moreover, scarcely any perceptible waste in the bars. Experiments have also been made with the use of the water-spray on a large scale for blast furnaces and other manufacturing purposes, and it is also capable of being used under certain conditions in domestic stoves.

The air-pressure needed to produce the spray is very moderate, even that due to water at a height of 33 feet suffices. The amount

* Abstract in *Proceedings* of Inst. of Civil Engineers of article in *Gesund-heitz Ingenieur* of July 31, 1895.

of water which can be consumed in the spray form varies, of course, with the size of the fireplace from two to six gallons per hour.

The advantages of this system of firing are thus summed up by the author: Great economy of fuel, absolute freedom from smoke, immediate production of extreme temperatures up to the melting point of platinum, adaptability of every description of fuel for the purpose, applicability of the system to all kinds of firing needed for industrial and domestic operations, and, lastly, the possibility of replacing by this means all existing regenerative systems and all plant adapted for firing with powdered coke, coal, etc.

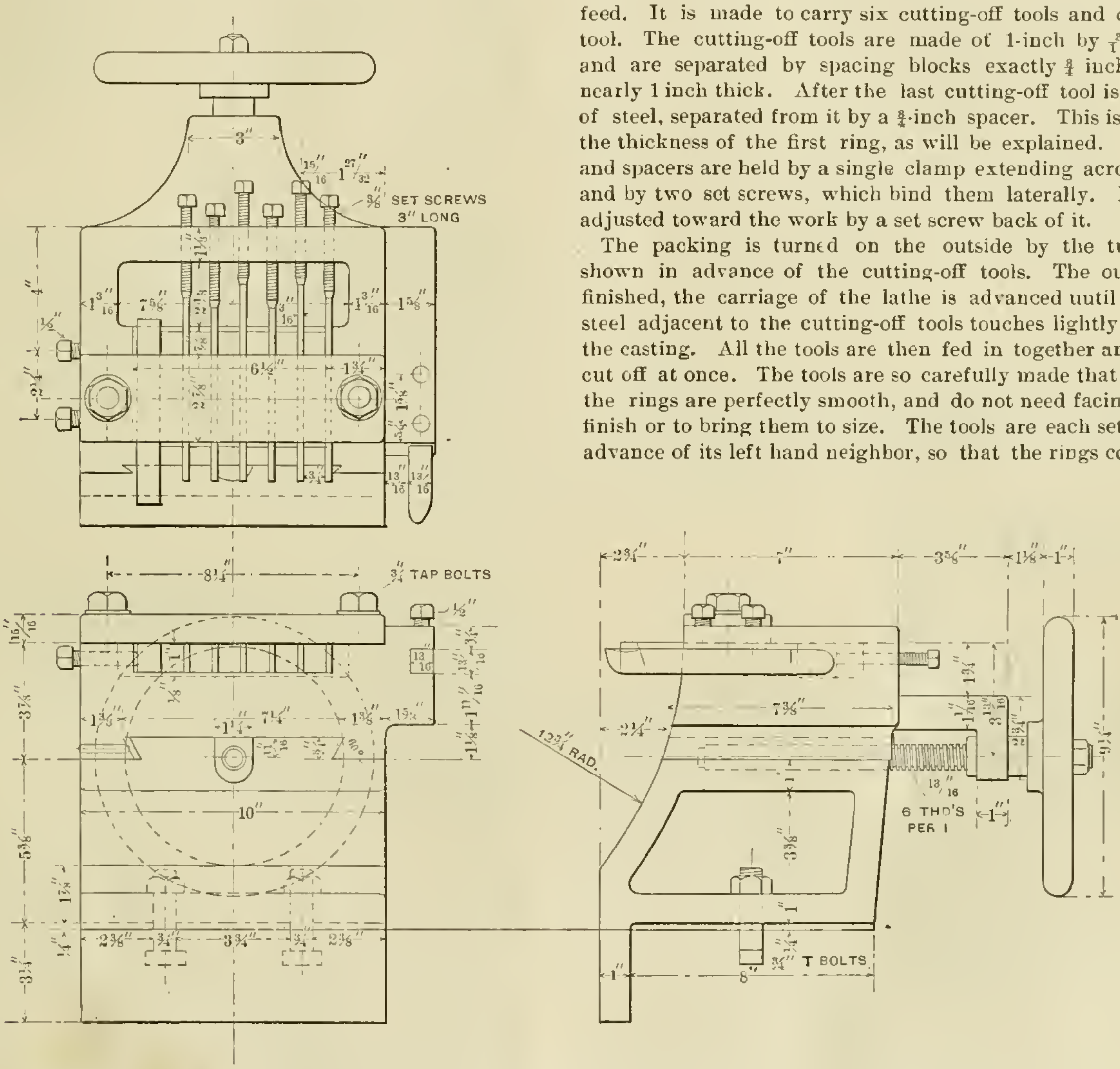
[These experiments seem to have a very important significance. There is a popular impression among firemen, which is very general, that wetting coal improves combustion. Besides doing this, it serves the purpose of preventing dust, and with very fine coal of coagulating the particles of coal until they reach the fire, and thus prevent them from being carried through the tubes and up the chimney by the draft. Some experiments have recently been made by a chemist, who took the purest oxygen and carbon which he could obtain, from both of which all moisture was extracted. When these were perfectly dry, it was found to be very difficult to make them combine, showing that a certain amount of moisture was required for combustion. It would be very interesting—and probably very profitable—if an investigation were made to establish the correctness of the conclusions reached in the article quoted above, and to determine under what conditions and in what quantities water-spray will improve combustion. It may be that this idea is of practical value.—EDITOR AMERICAN ENGINEER.]

Multiple Tool Post for Turning and Cutting-off Piston Packing.

The excellent practice of comparing costs of work in the various shops of the same railroad system led indirectly to the design of the multiple tool holder for turning and cutting-off packing shown herewith. In making such comparisons on the Chicago, Milwaukee & St. Paul system it was found that piston packing was produced at some of the shops for less than it cost at the West Milwaukee shops. Not to be outdone, the tool shown was designed for the work, and as a result packing for an 18-inch engine is turned out at a total cost for labor of 23 cents.

The tool holder is of special form and is mounted on the carriage of the lathe just ahead of the regular tool holder and well out toward the apron. It is provided with a transverse hand feed. It is made to carry six cutting-off tools and one turning tool. The cutting-off tools are made of 1-inch by $\frac{3}{16}$-inch steel and are separated by spacing blocks exactly $\frac{3}{4}$ inch wide and nearly 1 inch thick. After the last cutting-off tool is a plain bar of steel, separated from it by a $\frac{3}{4}$-inch spacer. This is for gaging the thickness of the first ring, as will be explained. These tools and spacers are held by a single clamp extending across them all and by two set screws, which bind them laterally. Each tool is adjusted toward the work by a set screw back of it.

The packing is turned on the outside by the turning tool shown in advance of the cutting-off tools. The outside being finished, the carriage of the lathe is advanced until the bar of steel adjacent to the cutting-off tools touches lightly the face of the casting. All the tools are then fed in together and six rings cut off at once. The tools are so carefully made that the sides of the rings are perfectly smooth, and do not need facing either for finish or to bring them to size. The tools are each set slightly in advance of its left hand neighbor, so that the rings come off one at a time and give the operator time to take care of them. After cutting off one group of six, the cutting-off process can be immediately repeated without facing off the end of the casting remaining on the face plate. The rings are left rough on the inside.

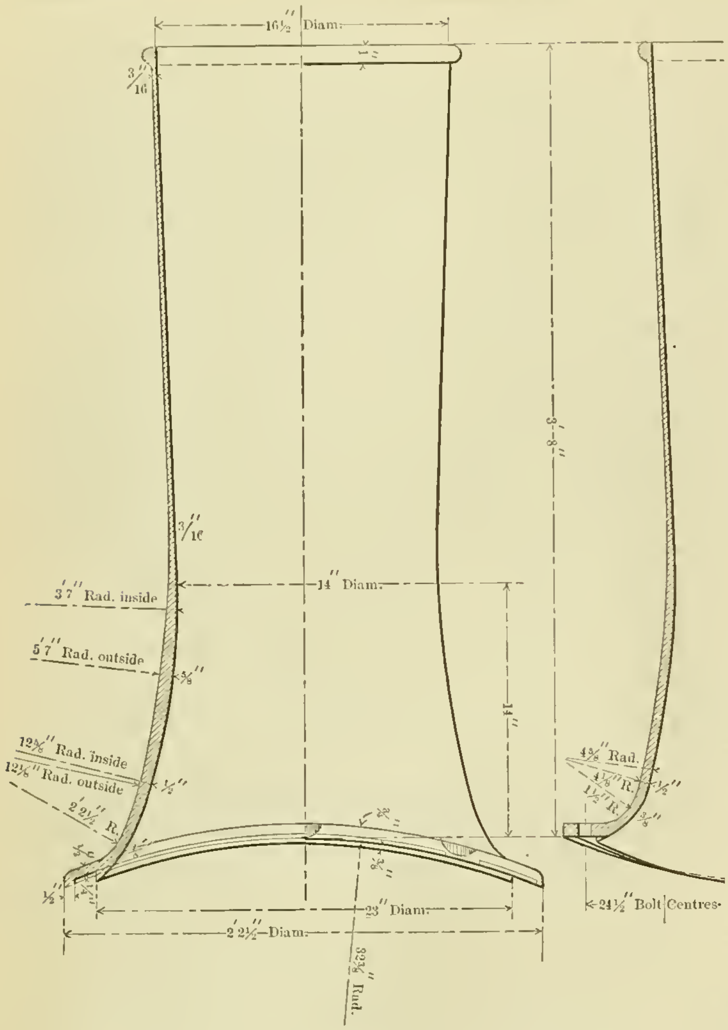


Multiple Tool Holder for Turning and Cutting Off Piston Packing Rings.

Quadruple-Expansion Marine Engine.

A somewhat novel departure in marine-engine practice, which will, no doubt, be followed with interest, has just been made by the Central Marine Engine Works of Messrs. William Gray & Company, Limited, of West Hartlepool, in the design of engines which they have fitted to the new steamer *Inchmona*, recently built by them to the order of Messrs. Hamilton, Fraser & Company, of Liverpool.

In the engines under notice there are five cylinders, the two low-



Cast Iron Smoke Stack.—C. & N. W. Ry.

pressure being of equal size. The whole of the five cylinders are arranged in line, and connected to five cranks, the cranks being set at equal angles throughout the circle, i. e., 72 degrees apart. The cylinders are respectively 17 inches, 24 inches, 34 inches, 42 inches and 42 inches in diameter.

The steam for the engines is supplied from boilers working at a pressure of 255 pounds on the inch. These are of the ordinary cylindrical multi-tubular type, and were tested by Lloyd's to 510 pounds per square inch. They are fitted with Mr. Mudd's system of superheating apparatus, combined with the well-known Ellis and Eaves' type of induced draught, and with Serve tubes and retarders. An attempt is here made not only to supply the engine with dry steam from the boilers, but to retain it in a dry state throughout the engine; and to this effect there are combined with the superheater an apparatus that Mr. Mudd calls an initial receiver, an exceptionally complete system of steam jacketing to the cylinders, and an exhaust control arrangement.

There is also an unusually elaborate scheme of feed heating. Instead of the usual single vessel, there are a series of feed heaters worked at graduated temperatures, and as the water passes through these it continues to rise in temperature until on entering the boilers it is nearly at the temperature of the steam. On the trials the thermometers registered about 400 degrees Fahrenheit as the temperature of the feed water as it passed the meter and entered the boilers. The feed-water filters are the Edminston patent, and Mudd's evaporator is used.

The five-crank system does not, as might be supposed, involve any great increase in length of engine-room space, as the reduced diameters of cylinders allow the centers to be closer. In the case of the *Inchmona*, the engine-room is only one frame space longer than for the same power in three-crank engines. The five-crank principle is put forward by the builders as most suitable for large powers and for long-voyage boats, where economy of fuel is of such vital importance. If the predictions of the builders are realized it will mean that some 500 or 600 tons of coal can be saved on the single round voyage to Australia or New Zealand of a cargo boat carrying 6,000 or 7,000 tons, at a speed of eleven knots.

The designers of the engines confidently anticipate that, by means of the various improvements effected, the consumption of coal will be brought down to a figure closely approximating to 1 pound per I. H. P. per hour.—*The Practical Engineer.*

Cast Iron Smoke Stack—Chicago & Northwestern Railroad.

In the accompanying drawing we show the standard cast-iron stack of the Chicago & Northwestern Railroad. The stack and base are all in one casting with the holes eored for securing it to the smokebox, so that there is no labor whatever expended on it, except to put it in place and paint it. Three patterns suffice for all engines. A single pattern is used for stacks of various lengths, the diameter at the base and throat and the taper being maintained while the diameter at the top depends upon the length. The stacks average somewhat more than 300 pounds in weight. As the castings cost three cents per pound (a special price for this particular line of work) the cost of the stack on the engine is less than ten dollars.

The Comparative Cost of Pintsch and City Gas for Car Lighting.

A valuable report on the cost of lighting passenger cars with city gas was recently made to Mr. R. H. Wilbur, General Superintendent of the Lehigh Valley Railroad, by Professors W. H. Chandler and J. E. Denton. The railroad company had in contemplation the problem of lighting their passenger equipment with gas, and had given some consideration to the plan of using city gas, burned in Gordon-Mitchell lamps. The Safety Car Heating and Lighting Company had made the road a proposition to furnish a generating and compressing plant for Pintsch gas, at Phillipsburg (just across the river from Easton), and operate it, covering all labor and expense necessary to charge the cars with sufficient gas to afford the same illumination as with the city gas, at the rate of $5.09 per thousand cubic feet stored on the cars. The object of the investigation and report was to determine which of the two propositions was the more economical.

The illuminating power of the city gas obtainable at Phillipsburg was assumed to be the same as that of Jersey City, which when burned uncompressed in an Argand burner at about 60 degrees Fahrenheit gave 5.22 candle power per foot. In the same burner, after compression to 17 atmospheres, it lost 54.2 per cent. of illuminating power. The Pintsch gas compressed by the experimenters at the Delaware, Lackawanna & Western Railroad Company's gas works, at Hoboken, to 12 atmospheres, when burned in the same burner, gave before compression 10.25 candle power per foot, and after compression lost only 4.4 per cent. of light.

The city gas when burned in Gordon-Mitchell lamps at the rate of 7.6 cubic feet, per hour gave about 29 candle power per lamp at 45 degrees, and for the 174 cars to be supplied at Easton and Phillipsburg there would be required 18,872 cubic feet per 24 hours. The Pintsch gas if burned in the Pintsch four-flame lamp or in their Argand burner would be consumed at the rate of 3.4 cubic feet per hour, consequently in the same number of lamps as used for the city gas the total consumption would be 8,443 cubic feet per 24 hours. The candle power would, however, be considerable more, being 54 candle power per lamp for the Argand burner and about 35 candle power for the four-flame lamp.

A comparison is first made between the two systems upon the basis of a consumption of 18,872 cubic feet of city gas and 8,443 cubic feet of the Pintsch gas. The lowest cost of compressed city gas at Easton is given at $2,883 per thousand, as follows:

LOWEST COST OF COMPRESSED CITY GAS AT EASTON FOR CONSUMPTION BY LAMPS OF 18,872 CUBIC FEET PER 24 HOURS.

Average of Summer and Winter Consumption.

Coal for compressing, at $1.75 per gross ton	4.25c. per thousand.
Water for compressing, at $1.00 per 1,000 cubic feet	1.19c. " "
Labor for filling cars and compressing	47.27c. " "
Material for repairs of charging system	11.40c. " "
Interest and depreciation on cost of compressing plant	17.50c. " "
Interest and depreciation on extra investment for car tanks using city gas over that required for tanks using Pintsch gas	15.65c. " "
Cost of city gas equivalent to Jersey City gas delivered to compressing stations at $1.50 per M, including extra cost due to unavoidable loss by leakage between compressor and cars of 20 per cent. of total gas	188.00c. " "
Total cost of city gas on cars at 270 pounds pressure	$2.883 " "

The items comprising the above statement were obtained as follows: The size of the compressing plant needed was first determined. In compressing the gas to 20 atmospheres and delivering it on the cars actual tests demonstrated there would be a loss through leakage and liquefaction of 20 per cent., of which 14 per cent. was for leakage alone. In a compound or two-stage compressor (which is the type recommended for the work) actual tests show the delivery of gas at 20 atmospheres does not exceed 57 per cent. of the piston displacement.

It was further found by observation at a point where about 100 cars are charged every 24 hours and 22,000 cubic feet of gas pass through the compressors that two-thirds of the gas is compressed during the day, and also that the maximum demand upon the compressors is about twice the average for the daylight hours. Taking all these facts into consideration, the required piston displacement of the compressors is found to be about 5,000 cubic feet per hour and two compressors of 2,500 cubic feet are recommended. These would run at 75 revolutions, but could be speeded up to 150 in emergencies. The price of each compressor is placed at $850 and the total cost of the compressor plant is given as follows.

Two compressors at $850	$1,700
Connections	50
Foundations	50
Labor of erecting	50
Building	244
Total	$2,094

Tests of a similar gas compressor showed that the indicated horse power per 1,000 cubic feet piston displacement at 20 atmospheres per hour was about 3.8 horse power. To displace at the rate of 2,500 cubic feet would therefore require 9.5 horse power. To pump from one storage reservoir into the others at the same rate would probably require 50 per cent. as much power, or 4.75 horse power, which added to the other would give a total of 14.25 horse power. Experiments show that 45 pounds of water must be evaporated per horse power to 60 pounds pressure, or 641 pounds of steam per hour. This would necessitate a boiler of about 22 nominal horse power with 10 square feet of grate and 300 square feet of heating surface, costing $300 set up and connected; adding $250 for the building makes the total cost of the boiler plant $550. If the company's boilers already at Phillipsburg can supply the steam this item can of course be omitted.

The storage capacity at the compressing station is taken at a figure large enough to charge a Buffalo train of three coaches and two sleepers at Easton in ten minutes, without interrupting the charging of cars in the yard. The Buffalo train would require 2,736 cubic feet and to charge a train of three coaches in the yard that were three-quarters exhausted would require 776 cubic feet. If such a train had to be charged within 20 minutes after the Buffalo train the total gas required in that period of time would be 3,512 cubic feet. Of this amount the compressors could pump in that time 1,000 cubic feet, leaving 2,512 cubic feet to be supplied from the reservoirs. To do this the reservoirs must have a capacity of 1,256 cubic feet. Five reservoirs 50 inches in diameter and 20 feet long would suffice, and their cost would be as follows:

Five reservoirs	$4,000
Valves and fittings	1,250
Foundations and shed (to protect reservoirs from sun heat)	300
Labor of erection	100
Total	$5,650

The pipe lines necessary to charge cars at Phillipsburg and Easton are computed to cost $2,972.

The cost of extra tank storage on the cars to hold the greater volume of city gas is given at $55 per car with five lamps, or for 174 cars $9,570. This estimate is based on one tank of 18.6 cubic feet capacity for Pintsch gas, containing enough gas for 14 hours' consumption, and two tanks of 14.5 cubic feet capacity for the city gas.

Combining the above items, the total investment for the use of city gas is found to be as follows:

Compressors, buildings and foundations for same	$2,094
Boiler, erected and housed	550
Storage reservoirs, erected and housed	5,650
Pipe lines and charging-fittings, in place	2,972
Investment for compressing plant	$11,266
Additional cost of car-tanks for 14 hours burning supply, using city gas, over that with Pintsch gas	9,570
Total investment	$20,836

The cost of operation was investigated in the same careful manner. It was found that the coal burned per 1,000 cubic feet of gas compressed for the lamps was 54.4 pounds, which at $1.75 per gross ton cost 4.25 cents per thousand. The water per thousand feet of gas compressed was 11.9 cubic feet, including jacket water for the compressor cylinder, which at $1.00 per thousand cost 1.19 cents.

The labor at the compressors and boiler house is placed at 21.46 cents per thousand feet if a separate boiler plant was required, and 19.37 cents if steam was taken from other boilers. For filling the cars it was found in another yard, where about 25,000 cubic feet is made per 24 hours, it was found that 3 day men working 12 hours at 14 cents per hour, and one night man working 12 hours at 11 cents per hour, were needed in winter. In summer 2 day men at 14½ cents and one night man at 11 cents did the work. Other yards were examined, and it was concluded that one day and one night man would be required at Easton, and one day man at Phillipsburg all the year round, making the cost of labor for filling 24.8 cents per thousand in winter, and 31 cents in summer (when the consumption would be 20 per cent. less than in winter) or an average of 27.9 cents throughout the year.

The cost of material for repairs was determined from the records of the Safety Car Lighting and Heating Company, no railroad records being available. It was found to be 14.4 cents per thousand.

Interest was taken at 6 per cent. and depreciation at 4 per cent., amounting to 18.41 cents if the separate steam boilers had to be used and 17.5 cents if they were not installed. The interest and depreciation on the extra tanks needed on the cars for the city gas must be added to this, it being 15.65 cents.

The city gas can be obtained at $1.50 per thousand feet from the city mains, but the loss from leakage and shrinkage already noted brings the cost per thousand feet actually consumed to $1.88.

We have now given the derivation of all of the items mentioned in the table, showing the total cost of the city gas on cars as $2.883 per thousand. The illuminating qualities of the two gases are next summarized in the following table:

RESUME OF ALL ILLUMINATING TESTS.

Relative Illumination per Cubic Foot of Gas Burned.

Candle power per cubic foot: Candle power with Gordon-Mitchell lamp, burning city gas at the rate of 7.6 cubic feet per hour, affording about 29 candle power at 45 degrees.

Tests in which photometer-disc was at equal distances from floor of car in tests of four lamps.

Lamp compared.	Cubic feet of gas per hour.	Candle power at 45 degrees.	Relative illumination per cubic foot of gas burned. Tests with single.	Tests with four.	Average.
1.	2	3	4	5	6
1. Gordon-Mitchell lamp, burning Pintsch gas	3.36	26.0	2.07	2.06	2.06
2. No. 1 Pintsch Argand lamp, burning Pintsch gas	3.41	54.3	4.42	3.76	4.09
3. No. 1 Pintsch Argand lamp	7.13	30.4	1.22	0.98	1.10
4. Four-flat flame Pintsch lamp, burning Pintsch gas*	....	.	3.12	2.73	2.92
Average	3.31	35.4	Aver. 3.02		Aver 2.87
5. Four-flat-flame Pintsch lamp, burning Pintsch gas*	....	....	2.92	2.73	2.82

Tests in which photometer-disc was at equal distances below the lamp flame centres in tests of four lamps.

Lamp compared.	Cubic feet of gas per hour.	Candle power at 45 degrees.	Tests with single.	Tests with four.	Average.
6. Gordon-Mitchell lamp, burning Pintsch gas	3.36	26.0	2.07	2.16	2.11
7. No. 1 Pintsch Argand lamp, burning Pintsch gas	3.41	54.3	4.42	3.44	3.93
8. No. 1 Pintsch Argand lamp, burning city gas	7.13	30.4	1.22	0.89	1.05
9. Four-flat-flame Pintsch lamp, burning Pintsch gas*	....	....	3.12	2.50	2.81
Average	3.31	35.4	Aver. 3.02		Aver 2.76
10. Four-flat-flame Pintsch lamp, burning Pintsch gas†	....	....	2.92	2.50	2.71

In tests marked * the four-flat-flame Pintsch lamp was set so that each of the four flames are at an angle of 45 degrees to a vertical plan was passing through the centre of the lamp and of the photometer-disc.

In tests marked † the lamp was set so that one of the four flames was toward, and parallel to, a vertical plane passing through the axis of the photometer-disc.

The following conclusions are drawn from the data presented above:

I. If 1,000 cubic feet of Pintsch gas was burned in the Pintsch Argand lamps while the latter afforded the illumination corresponding to about 54 candle power for a certain number of burning

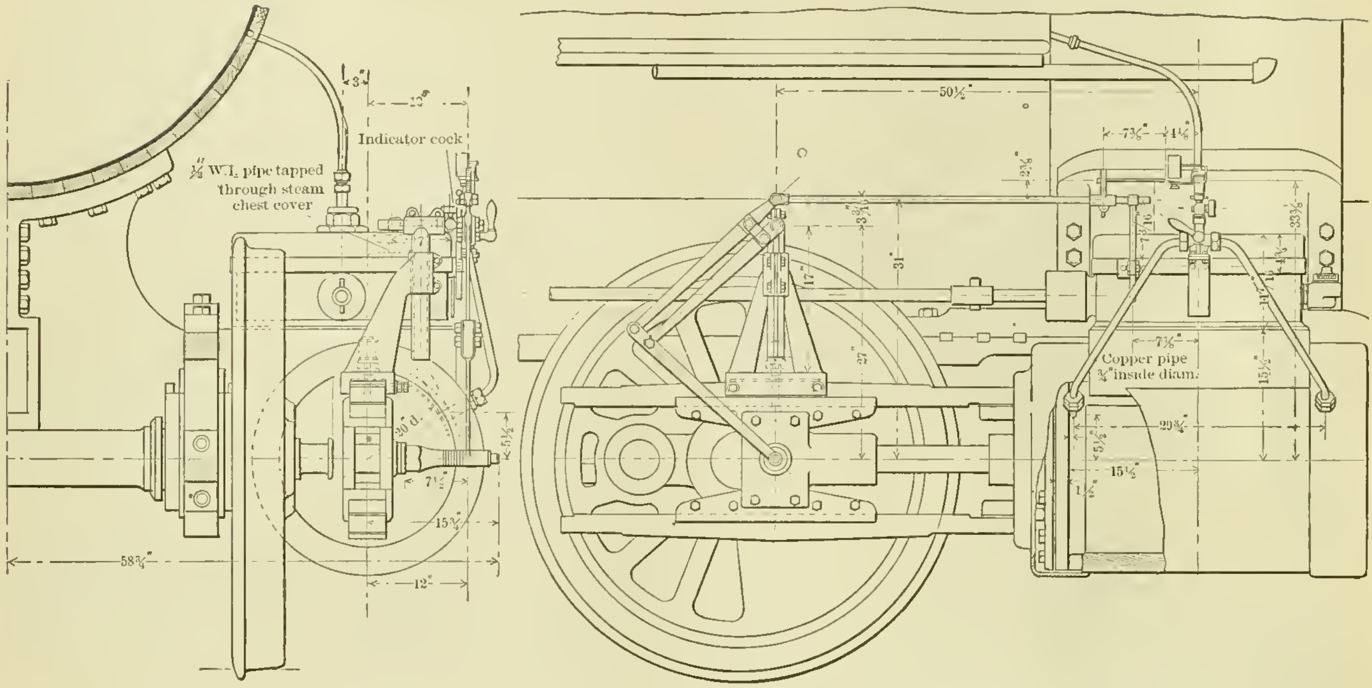


Fig. 1.—General Arrangement of Indicator Rig Applied to a Class R Locomotive.—Pennsylvania Railroad.

hours, then, by line 7, column 4, of the above table, 3,930 cubic feet of city gas must be burned in the Gordon-Mitchell lamps, affording about 29 candle power at 45 degrees, in order to obtain the same total amount of illumination. The cost of obtaining this illumination from the Pintsch lamps would be $5.09 per M; and from the Gordon-Mitchell lamps, $2.883 × 3 93 = $11.33 per M.

In other words, the Pintsch gas might be sold at $11.33 and be as cheap per unit of illumination as the city gas at its cost of $2.883 per thousand stored on the cars. In view of the large difference in candle power of the two lamps, however, equal illumination could not be afforded by them in a car, unless there were nine Gordon-Mitchell lamps to about five Pintsch lamps. Under this arrangement the relative cost of the equal illumination would not be practically altered from the above figures. Such a difference in the number of lamps is, of course, impracticable, so that a use of the Pintsch Argand lamps with Pintsch gas must be accompanied with greater illumination in the car than is obtained from an equal number of Gordon-Mitchell lamps at the service rates of consumption for each which was used in the experiments.

If we do not attempt to represent the difference of the light in the cost of the gas, the comparative cost of the two systems may be represented by the cost per car hour.

This cost, using five Pintsch Argand lamps with Pintsch gas, affording about 54 candle power at 45 degrees, at $5.09 per M, is 8.7c. per car hour.

The similar cost for five Gordon-Mitchell lamps, affording about 29 candle power at 45 degrees, with gas at $2.883 per M, is 11.0c. per car hour.

Therefore, the use of the Pintsch Argand system costs, for gas, about 20% less per car hour than the Gordon-Mitchell system, and affords about 70% more illumination below the horizontal; the candle power at 45 degrees representing about the average intensity of the light over its lower hemisphere of action. The equivalent annual saving by using the two lamps, therefore, neglecting the fact that the Pintsch lamp affords this extra amount of illumination, is as follows:

The average consumption of city gas would be 6,199,525 cubic feet per annum, costing $17,873. The equivalent amount of Pintsch gas would be 2,761,629 cubic feet per annum, costing $14,158. There would, therefore, be an annual saving of $3,715 per annum by the use of the Pintsch Argand system, as compared to the Gordon-Mitchell system, with an illumination proportional to about 29 candle power from the latter system as compared with an illumination proportional to 34 candle power from the Pintsch system.

II. Comparing the Gordon-Mitchell lamp using city gas with the Pintsch four-flat-flame lamp consuming 3.31 cubic feet per hour, affording 35.4 candle power at 45 degrees, the annual costs are as follows:

The total city gas consumed per annum would be 6,199,525 cubic feet, costing $17,873 as before. The total Pintsch gas consumed per annum would be 2,700,056 cubic feet, which would cost $13,743. The use of the Pintsch four-flat-flame lamp would, therefore, save $4,130 per annum over the use of the Gordon-Mitchell lamp with city gas, or the cost of the Gordon-Mitchell gas equals that of the Pintsch gas bought at $6.62 per thousand, and the Gordon-Mitchell lamps afford 20 per cent. less illumination in the most useful direction in the car. If the gas consumption of the four-flat-flame lamp was restricted so that its candle power should be practically the same at 45 degrees as that of the Gordon-Mitchell lamp, the annual saving would be $6,370, or, in other words, the cost of the city gas in Gordon-Mitchell lamps is equivalent to Pintsch gas at $7.90 per thousand.

A Substantial Indicator Rigging for Locomotives.

The more frequent use of the indicator on locomotives has resulted in more carefully designed and better indicator rigs. When indicating locomotives was a novelty in which the master mechanic or chief draftsman indulged about once a year, the cheapest rig that would hold together for that particular time was good enough; now on large railroad systems a substantial rig is desired, and one that is adjustable to many classes of engines. For this reason we think our readers will be interested in the latest rig used on the Pennsylvania Railroad and shown in the accompanying illustrations.

Fig. 1 shows the general arrangement and the manner of applying it to a "Class R" consolidation locomotive. Figs. 2 and 3 give some of the important details. The indicator drum is driven by means of a parallel motion attached to the cross-head pin and supported on an adjustable standard on the top guide. To attach this standard the guide oil cup is removed and an oil stud inserted which bolts the standard down and into the top of which the oil cup is placed. The standard has flanges extending down each side of the guide and is further secured by two pointed set screws in the front flange. The face of the guide has conical recesses to receive the points of the screws. In the upper end of the standard is clamped a vertical cast iron column 2 inches in diameter which is adjustable in height and prevented from turning by a key. The upper end of this column carries a horizontal shaft 1¼ inches in diameter which can be firmly clamped and is adjustable laterally. At its outer end it has a journal 1 inch by 2 for the upper end of one of the long links of the parallel motion.

The various parts of this parallel motion, except the pins and bushings, are shown in detail in Fig. 2. They are all wrought iron cast hardened, and the holes *A*, *B*, *C*, *D* and *E* are provided with bushings. These are a driving fit in the two upper links in Fig. 2, and a working fit in the holes correspondingly lettered in the other links. The bushings are a shade longer than the total width of the links through which they pass, so that the ⅜-inch bolts inserted through them hold the parts together without binding. The attachment to the crosshead is effected by removing the nuts on the crosshead pin, and in their place putting on first a hexagonal check-nut ½ inch thick and then screwing on the extension piece shown in Fig. 2. This has a 3-inch by 1-inch journal, which can be adjusted laterally 2⅝ inches by means of the leather washers shown.

The indicator three-way cock is firmly bolted to a bracket on

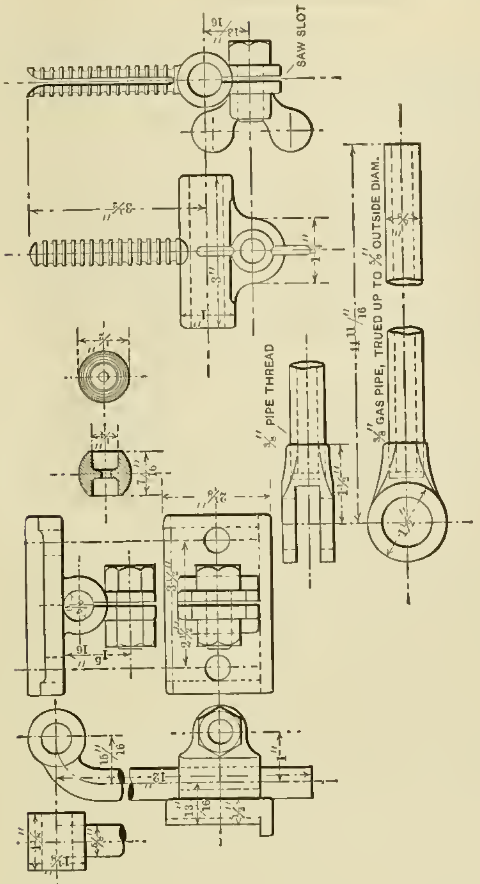


Fig. 3.

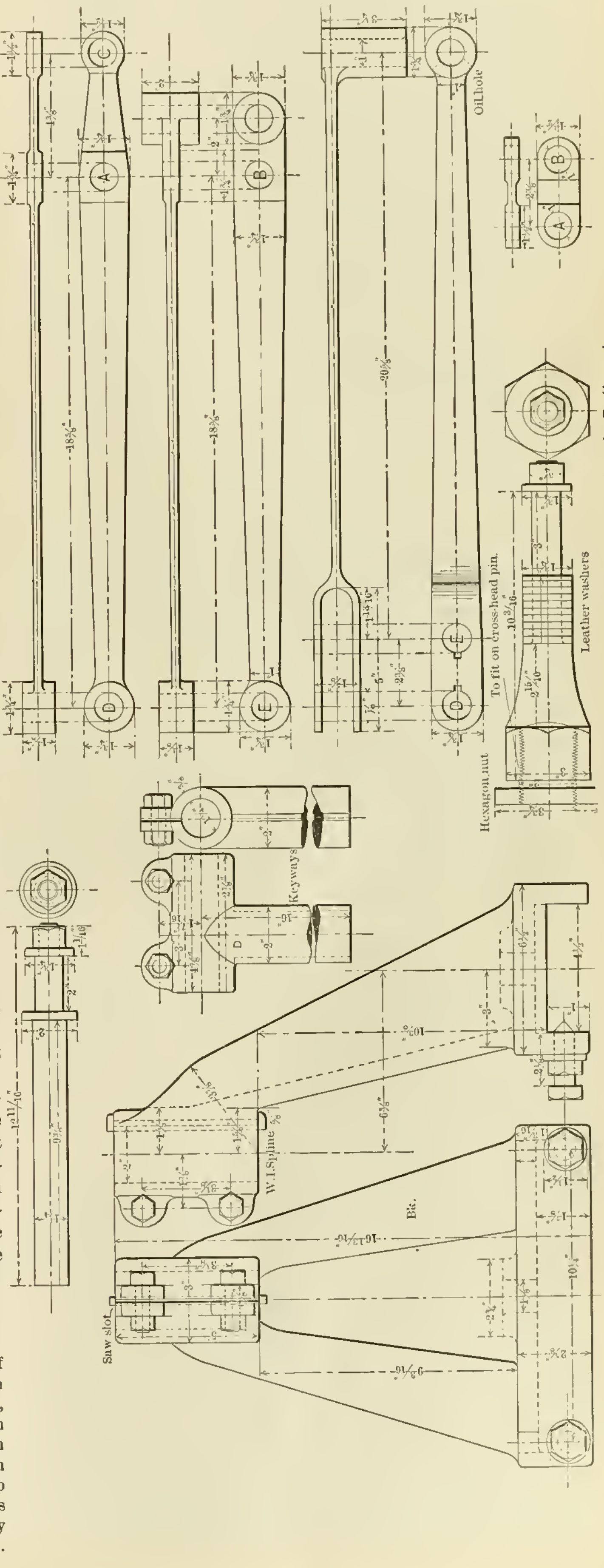


Fig. 2.—Details of Indicator Rig for Class R and Other Locomotives.—Pennsylvania Railroad.

the outside face of the steam chest casing. It is placed as low down as convenience of operation will permit, and being outside of the casing, the pipes to it are more direct and shorter than usual. The cock is piped to the steam chest also. The connection from the parallel motion to the indicator arm consists of a long piece of ⅜-inch iron pipe, with a jaw at its rear end and supported at the front end by an adjustable standard attached to the face of the steam-chest casing. Clamped on to this pipe is an upright pin that is split for the cord and is grooved on the outside to keep the small brass button on the end of the cord from slipping. To connect the cord it is only necessary to pull it out and drop it through the slit in the pin. Disconnecting it is equally easy. This neat arrangement will be appreciated by those who have experienced the difficulties of taking cards at high speeds The details are shown in Fig. 3.

From our description and the illustrations it will be seen that this rig is not only convenient and durable, but it is adjustable in every direction and can be attached to locomotives varying considerably in dimensions. The motion to the drum is perfect, the cord is short and easily connected, and the steam pipes are short and direct. Altogether it is excellent. Mr. A. W. Gibbs, engineer of tests, states that some of the ideas were obtained from the rig used by Professor Goss on the locomotive at Purdue University, but this rig had to be adapted for road service and the features pertaining to the adjustment to various engines and the attachment for the cord are new.

A New Water-Tight Bulkhead Door for Steamships.

In connection with the construction of battleships, as well as of mercantile vessels, there has always been room for improvement in the matter of bulkhead doors. So important a point is it, in fact, that some time ago the British Admiralty appointed a Commission to consider the subject, with the object of adopting some plan whereby the risks run through the water-tight doors being left open would be minimized. The terrible disaster to the British battleship *Victoria*—which might have been averted had the bulkhead doors been closed—has only to be remembered to show the great necessity for adopting some method of preventing occurrences of the kind. It would seem that now the difficulty has been solved, for Mr. Wm.

Kirkaldy, of Glasgow, has invented a bulkhead water-tight door which it is absolutely impossible to leave open. The feature of Mr. Kirkaldy's patent door is its wonderful simplicity. It consists of a hollow cylindrical door, which revolves within a suitable casing, fixed to, or forming part of, a water-tight bulkhead. By combining this revolving cylindrical door and casing a double-door is formed, which effectually prevents the ingress of fire, water, etc., through the bulkhead, yet on being revolved by hand allows free thoroughfare between water-tight compartments, with the certainty that at all times and under all conditions *one of the doors is absolutely closed*, thus guaranteeing that the bulkhead is intact and thoroughly reliable in the event of a sudden disaster. When the doorways in casing and the revolving cylindrical door are in line free passage through the bulkhead is gained by entering and standing inside of the casing and revolving it by hand, when the ingress doorway in casing is absolutely closed before the opening in the revolving door comes in line with the second doorway to allow egress from the casing. In the event of a collision there is absolutely nothing to be done in the way of closing the water-tight doors. As the doors are never open no gearing is required to close them, thus obviating the necessity of bulkhead drill, and allowing the crew to perform other urgent work. The invention has been shown to a number of naval and engineer experts and others interested in shipping matters, who have expressed their approval of its merits and the exceptional features of safety which the door possesses.—*The Steamship.*

Successful Trial of Professor Langley's Aerodrome.

Some of the best contributions to the science of aerial navigation have come from Professor Langley, Secretary of the Smithsonian Institution, and it is well known that he has been making experiments in this direction for a long time. Recently he has been at work upon a machine of his own invention and a trial of it was made May 6, near Occouvan, Va., in the presence of Prof. Alex. Graham Bell. The New York *Sun* of May 14 publishes the following account of the trial as given out by Professor Bell and endorsed by Professor Langley:

"The aerodrome, or 'flying machine,' in question was of steel, driven by a steam engine. It resembled an enormous bird, soaring in the air with extreme regularity in large curves, sweeping steadily upward in a spiral path, the spirals with a diameter of perhaps 100 yards, until it reached a height of about 100 feet in the air, at the end of a course of about half a mile, when the steam gave out, the propellers which moved it stopped, and then, to my further surprise, the whole, instead of tumbling down, settled as slowly and gracefully as it is possible for any bird to do, touched the water without damage, and was immediately picked out and ready to be tried again.

"A second trial was like the first except that the machine went in a different direction, moving in one continuous gentle ascent as it swung around in circles like a great soaring bird. At one time it seemed to be in danger, as its course carried it over a neighboring wooded promontory, but apprehension was immediately allayed, as it passed 25 or 30 feet above the tops of the highest trees there, and, ascending still further, its steam finally gave out again, and it settled into the waters of the river not quite a quarter of a mile from the point at which it arose. No one could have witnessed these experiments without being convinced that the practicability of mechanical flight had been demonstrated."

Professor Langley also made public a supplemental statement, giving some important data regarding experiments. He said: "The aerodrome or flying machine has no gas to lift it, as in the case of a balloon, but, on the contrary, it is about one thousand times heavier, bulk for bulk, than the air on which it is made to run, and which sustains it somewhat in the way in which thin ice supports a swift skater. The power is derived from a steam engine, through the means of propellers, but, owing to the scale on which the actual aerodrome is built, there has been no condensing apparatus to use the water over and over. Enough can be carried for only a very brief flight, a difficulty which does not belong to larger machines than the present example, in which the supporting surfaces are but about fourteen feet from tip to tip. The distance flown each time was about one-half mile. The rate of speed depends (as in the case of any vehicle on land) on whether it is going on a level or up hill. In the case of this last trial of May 6 the machine was ascending, that is to say it was going up hill all the time, and went through a distance of one-half mile or more in one and one-half minutes, or at the rate of a little more than twenty miles an hour."

Personal.

Mr. A. S. Dunham, General Manager of the Ohio Southern road, has resigned.

Mr. H. A. V. Post, of New York, has been chosen President of the Chattanooga Southern.

Mr. H. W. Matters, Purchasing Agent of the Louisville, Evansville & St. Louis, has resigned.

Mr. E. P. Huston, Joint Receiver with Mr. E. O. Hopkins, of the Peoria, Decatur & Evansville, has resigned.

W. A. Meagher has been appointed Master Mechanic of the Gulf & Interstate, with office at Galveston, Tex.

Mr. Charles E. Levy, of New Orleans, La., has been chosen President of the New Orleans & Western Railroad.

Mr. O. Emerson Smith, of Portsmouth, Va., has been appointed Receiver of the Norfolk & Virginia Beach Railroad.

Mr. Walter Layman has been appointed Master Mechanic of the Ohio River Railroad, vice A. L. Courtrite resignad.

Mr. Aldace F. Walker has resigned as Receiver of the St. Louis & San Francisco, and Mr. J. J. McCook is now sole Receiver.

Mr. A. J. Beltz has resigned the position of Master Mechanic of the Delaware, Susquehanna & Schuylkill Railroad at Drifton, Pa.

Mr. Joseph Dickson has been appointed Receiver of the Litchfield, Carrollton & Western, in place of Mr. C. H. Bosworth, resigned.

Mr. F. E. House has been appointed Chief Engineer of the Butler & Pittsburgh road, the new line to be constructed by Carnegie interests.

Mr. F. W. Huidekoper, of New York, has been elected President of the Chicago, Peoria & St. Louis road, in place of Mr. Henry W. Putnam, Jr.

Mr. H. H. Swift has been appointed General Car Foreman of the Cincinnati, Hamilton & Dayton Railroad, with headquarters at Lima, O.

Mr. Charles H. Grundy has been appointed General Manager of the Marshfield & Southeastern, with office at Marshfield, Wis., vice A. A. Hopkins.

Mr. J. H. Hill has been appointed General Manager of the Galveston, Houston & Henderson, taking effect May 15, with headquarters at Galveston, Tex.

J. H. Reed has resigned the Vice-Presidency of the Pittsburgh & Lake Erie Railroad Company, to identify himself with the Carnegie railroad interests.

Mr. E. D. Bronner, Master Car Builder of the Michigan Central, has been appointed Assistant Superintendent of Motive Power of that road, with headquarters at Detroit, Mich.

Mr. George T. Jarvis, who has been recently appointed Receiver of the Louisville, Evansville & St. Louis Consolidated road, will also act as General Manager of the company.

Mr. M. F. Bonzano, late General Superintendent of the South Jersey, has accepted the position of General Manager of the Chattanooga Southern, with headquarters at Chattanooga, Tenn.

Mr. W. Cockfield has resigned the position of Locomotive and Car Superintendent of the Interoceanic Railway and has been appointed Master Mechanic of the Mexican Central, at San Luis.

Mr. C. H. Doebler, formerly Master Mechanic of the Big Four at Wabash, Ind., has been appointed Master Mechanic of the Eastern division of the Wabash Railroad, with headquarters at Fort Wayne, Ind.

Mr. Frank J. Zerbee has been appointed Master Mechanic of the Michigan division of the Cleveland, Cincinnati, Chicago &

St. Louis, with headquarters at Wabash, Ind., to succeed Mr. C. H. Doebler, resigned.

Mr. W. J. Karner has resigned as General Manager of the St. Louis, Belleville & Southern road and the Crown Coal and Tow Line, which are now controlled by the Illinois Central, and the office has been abolished.

Mr. J. Layng has been elected Second Vice-President of the West Shore road, in addition to the office of General Manager, which he has held for several years. He is also the second Vice-President of the Big Four.

Mr. W. R. McKeen, Jr., has been appointed General Foreman of the locomotive department of the Vandalia line, with headquarters at Terre Haute. He retains his position of General Foreman of the car department.

Mr. Thomas Trezise, Master Mechanic of the Philadelphia division of the Baltimore & Ohio, has been transferred to the Pittsburgh division, with headquarters at Pittsburgh. Mr. E. T. White succeeds him at Philadelphia.

Mr. George W. N. Reed, formerly Treasurer of the Pratt & Whitney Company, of Chicago, has been elected Vice-President and General Manager of the company. He has been succeeded as Treasurer by Mr. J. C. Stirling.

Mr. C. J. Clifford has been appointed Superintendent of Motive Power of the Chicago, Lake Shore & Eastern Railway Company. Mr. E. B. Smith is appointed Master Car Builder, reporting to Superintendent of Motive Power.

Mr. I. N. Kalbaugh, Master Mechanic of the Baltimore & Ohio at Glenwood, Pa., has been appointed Division Superintendent of Motive Power of that road, with headquarters at Baltimore, Md., to succeed Mr. A. J. Cromwell, resigned.

Mr. G. W. Dickenson has been appointed General Manager of the Northern Pacific, with headquarters at Tacoma, Wash. Mr. W. L. Darling has been appointed Chief Engineer, with headquarters at St. Paul, vice E. H. McHenry.

Mr. W. A. Bell, foreman of the shops of the Cleveland, Cincinnati, Chicago & St. Louis, at Dillon street, Indianapolis, Ind., has been appointed Master Mechanic of the Louisville division of that road, with headquarters at Louisville, Ky.

Mr. T. J. Hennessy, formerly Traveling Engineer of the Michigan Central, has been appointed Division Master Mechanic of that road, with headquarters at Jackson, Mich. Mr. Peter Miller, Acting Master Mechanic, has been made Master Mechanic.

Mr. E. S. Washburn, Vice-President of the Kansas City, Fort Scott & Memphis, was on May 12 chosen President of the Kansas City Belt Railway and the Kansas City Union Depot Company, positions made vacant by the decease of Mr. George H. Nettleton.

Mr. H. G. Frazer, Auditor and Purchasing Agent, and Mr. E. Fairfax, Treasurer, of the Knoxville, Cumberland Gap & Louisville, have retired from their respective positions on account of the sale of the road to the Southern Railway, and the offices have been abolished.

Mr. E. V. Sedgwick, formerly Master Mechanic of the Mexican Central, and for a short time Locomotive and Car Superintendent of the Interoceanic Railway, has been appointed Superintendent of Motive Power and Superintendent of Transportation of the latter road.

Mr. William H. Schoen, of the Schoen Manufacturing Company, and a brother of the President of that company, died on May 18, aged 54 years. Mr. Schoen became associated with the company at the time of its organization and remained with it up to his death.

Mr. P. M. Hammett has been appointed Division Master Mechanic of the Boston & Maine, at Boston, vice Mr. A. B. Barrett. Mr. D. A. Smith has been appointed Master Mechanic of the Eastern, Western and Northern divisions, with headquarters at Somerville, Mass.

Mr. Bernard Vogle has been appointed Mechanical Engineer of the Delaware & Hudson Canal Company, with office at Green Island, N. Y. Mr. Vogle has been with this road for nearly ten years as Chief Draftsman, and has practically occupied the position of Mechanical Engineer for the past three or four years.

Owing to his protracted illness, the Directors of the Pennsylvania Railroad have granted General Superintendent Mr. F. L. Sheppard an indefinite leave of absence, and appointed Mr. J. M. Wallis, at present Superintendent of Motive Power on the division, Acting General Superintendent during Mr. Sheppard's disability.

Mr. Adolph Buize has been appointed General Purchasing Agent for the Grand Trunk road. At one time he was Purchasing Agent of the Missouri Pacific, but recently he has been in the railroad supply business at St. Louis. The Grand Trunk heretofore has not had a Purchasing Agent, the department being in charge of the General Storekeeper.

Mr. J. T. Odell has resigned as Second Vice-President and General Manager of the New England Railroad to accept the presidency of the Butler & Pittsburgh, projected from Butler to Pittsburgh, Pa. His headquarters will be at the latter place. Mr. Odell was Vice-President and General Manager of the New York & New England and its successor, the New England, since 1893, previous to which date he was for four and one-half years General Manager of the Baltimore & Ohio.

Mr. William S. Sloan, Second Vice-President of the Delaware, Lackawanna & Western Railroad, died May 12, of paralysis, at South Wilton, Conn., where he has been undergoing treatment for nervous prostration for some time. Mr. Sloan was the son of the President of the Delaware, Lackawanna & Western. He was born in Brooklyn in 1859, and was graduated from Columbia in 1882. He entered the service of the Delaware, Lackawanna & Western Railroad and rose to the position of Second Vice-President. He was Vice-President of the Fort Wayne & Jackson Railroad, a director in the Bank of the State of New York, a member of the Executive Committee of the American Tract Society, treasurer of the South Dutch Reformed Church and secretary of the Columbia College Alumni Association. Mr. Sloan was of a quiet and studious nature and greatly interested in the work of the Y. M. C. A., having been one of the heads of that association in this country. Mrs. Sloan and five children survive him.

Col. Frank K. Hain.

No event which has occurred for a long time has caused so much pain and produced such a shock to those who knew him, as the tragic death of Colonel Hain, which occurred at Clifton Springs, N. Y., on May 9. He had been suffering from nervous prostration for several months and had gone to a sanitarium for rest and medical treatment. On the afternoon of the 9th he left the institution and walked down to view the railroad station. Soon after he was discovered under a moving train, some of the cars of which had passed over him. When taken out he was still living, but died before medical aid reached him. The accident was not seen by any one and it is not known how it occurred. For the following particulars relating to his life and career we are indebted to the New York *Herald*:

"Colonel Frank K. Hain was born in Berks County, Pennsylvania, about fifty years ago, and commenced his railway career in early youth as an apprentice in the machine shop of the Philadelphia & Reading Railroad. Here, by constant attention and unwearied application, he early in life fitted himself for the eminent position he afterward occupied among American engineers.

"At the end of his apprenticeship he entered the United States Navy at the age of twenty-one as an engineer, serving for two years, and participating in some of the most memorable naval engagements of the late war. Among these were the capture of Forts Jackson and St. Philip and the city of New Orleans by the fleet under Admiral Farragut.

"Withdrawing from the navy he entered into still more active service in the army, in which he won reputation as a brave and gallant officer. At the close of the war he obtained employment as a draughtsman with the Delaware, Lackawanna & Western Railroad Company at Scranton, after which he entered the service of the Pennsylvania Railroad Company at Altoona. Here his abilities as an executive officer were soon acknowledged, and he was promoted to be Superintendent of Motive Power for the Philadelphia & Erie Division of the road.

"From this position he withdrew to accept charge of the designing department of the great Baldwin Locomotive Works, of Philadelphia. In 1871 he visited Russia in the interest of the firm and spent some 15 months in introducing and putting into operation 20 anthracite coal-burning locomotives which he had previously designed.

"Colonel Hain was offered the position of Superintendent of Motive Power on the Erie Railroad two years later, which he accepted. He afterward became General Superintendent of the Keokuk & DesMoines Railroad, maintaining his position after the road became merged into the Chicago, Rock Island & Pacific system

"Colonel Hain was best known to the New York public through his connection with the elevated railroads of this city. When the New York and the Metropolitan Elevated Railroad lines were leased to the Manhattan Company it was found that a competent man was needed as General Manager or Superintendent. Russell Sage and the late Jay Gould recommended to the Board of Directors that Colonel Hain be appointed to the position."

It is not easy, in a brief summary like this, to do justice to the life and character of a man like Colonel Hain, as he was generally known among his friends. He was a man of indefatigable industry and energy, and perhaps in the position which he occupied his greatest deficiency was his inability to lay responsibilities on other shoulders, instead of assuming them himself. The remarkable record of the road which he managed for so many years, which has carried many millions of passengers during that period, with almost complete immunity from accident, excepting through the fault or carelessness of those who were injured, shows how ably and conscientiously every department was supervised. By day and by nght, in sunshine, fog and storm, the responsibility for the operation of this road was borne by Colonel Hain, with little relaxation and no complete relief. More than a year ago there were signs of physical failure, but against the advice of friends, he continued in the harness. A few months ago work was no longer possible, and be received leave of absence and went, it was reported, South, for rest and recuperation. The few weeks before his death were spent at Clifton Springs.

To those who were not intimately acquainted with him he was reserved and reticent, but, once in his confidence, he was a genial companion and warm-hearted friend. He was deeply interested in his occupation, and faithful and loyal to those who employed him—much more so than they were and are to the public, which they ought to serve better than they do. In his domestic relations Colonel Hain's life was very happy. His wife was a true helpmeet to him, and guarded him in every way possible from the cares and annoyances incident to his occupation. To those who were privileged to enjoy the friendly and confidential talks with him in his own household they will always be a memory to be cherished as long as life lasts. To some who survive him his life and death may serve as a warning, by others it will be tenderly remembered, and to all he may be an example of faithfulness and loyalty to duty.

The Passenger Department of the New York Central road has just issued a new summer folder, entitled "America's Great Resorts." It is number three of the "Four Track Series" of folders, and is replete with information of a practical kind. All the leading resorts, both east and west, are mentioned in it, and the rates and time from New York and from Niagara Falls approximately given. This information will be found valuable to those who contemplate a summer trip, in arranging the details of their journey. The folder is handsomely illustrated and contains a large and accurate map. A copy of the folder can be obtained by sending four cents in stamps to Mr. Geo. H. Daniels, General Passenger Agent of the road, New York City.

The *Scientific American* is going to celebrate its fiftieth anniversary on July 25, by issuing a special number, one of the features of which will be a prize essay on the "Progress of Invention During the Past Fifty Years." A premium of $250 will be paid for the best essay of not more than 2,500 words. The five next best essays will be published later and paid for at regular rates.

Equipment Notes.

The specifications are out for 200 cars for the Chicago Great Western.

The Florida East Coast Railway is in the market for 100 ventilated box cars and 100 flat cars.

The Cold Blast Transportation Company., Kansas City, is in the market for 100 refrigerator cars.

The Georgia & Alabama road is in the market for six locomotives, three passenger and three freight.

H. K. Porter & Company have received an order for a locomotive for the Rockhill Stone Storage Company.

The Parkersburg shops of the Ohio River road have just turned out a private car for Vice-President G. A. Burt.

The Lehigh Valley has ordered 25 freight and 5 passenger locomotives from the Baldwin Locomotive Works.

The Texas & Pacific has contracted with the Mount Vernon Car Manufacturing Company for 300 freight cars.

The Pennsylvania Railroad has received two large wrecking cars from the Industrial Works, of Bay City, Mich.

The Erie road is building an 80,000-lb. coal car which is to be fitted with automatic devices of the Dumping Car Improvement Company.

The Southern Railway has contracted for six freight engines with the Brooks Locomotive Works and four with the Pittsburgh Locomotive Works.

The Pullman Palace Car Company has received an order for 20 passenger cars for the Brooklyn Bridge at $3,200 each. The cars are to be provided with electric motors.

The Great Northern is receiving 400 ballast cars from the Roger Ballast Car Company. The cars are combination ballast, coal and ore cars with a capacity of 20 cubic yards or 30 tons.

The Munising Railroad has placed orders through J. T. Gardner, Chicago, for 200 flat cars, 100 going to the Barney & Smith Car Company and the other 100 to Haskell & Barker Car Company.

The Chicago, Milwaukee & St. Paul is providing a convenient means of transporting bicycles without damage by putting in its baggage cars overhead rods carrying rubber-covered hooks on which they can be hung.

The Baltimore & Ohio has contracted with the Safety Car Heating and Lighting Company for the equipment of 200 passenger cars with the Pintsch light. Pintsch gas plants will be erected at Baltimore, Washington and Pittsburgh.

According to the statement of the receivers to the court, the new cars for the Philadelphia & Reading recently ordered were contracted for at the rate of $575.83 for each coal car; box cars, $607.83; gondola cars, $475.82; refrigerator cars, $892.83.

A law has been passed requiring the Manhattan Elevated to light its passenger cars by gas or electricity. It requires 40 per cent. of the company's cars to be so equipped within one year, 40 per cent. more within two years and all of the equipment within three years.

The ten switch engines built for the Chicago & Northwestern Railway by the Schenectady Locomotive Works are equipped with Latrobe open hearth steel tires, Midvale steel connecting rods, Nathan lubricators and injectors, five with American and five with Richardson balance valve, Ashcroft gages and Ashton pop safety valve. The boilers are made of carbon steel and covered with the "salt mountain" asbestos covering, mentioned in our May issue, of which Bruner, Sprague & Company, of Chicago, are the agents.

Contracts for the 5,000 new freight cars for the Baltimore & Ohio Railroad were given out early in the month as follows: South Baltimore Car Works, 1,000; Pullman Palace Car Company, 1,000; Missouri Car and Foundry Company, 900; Michigan-Peninsula Car Company, 800; Barney & Smith Car Company, 800, and Mount Vernon Car Company, 500. Of this order 1,800 are single-hopper cars, 1,800 box cars, 1,000 coke cars and 400 double-hopper coal cars. It is stated that the Buckeye coupler and the Schoen pressed steel bolster will be used on all of these cars, the Chicago roof on the box cars, and that the order for springs has been divided among the Pickering Spring Company, the A. French Spring Company and the Chas. Scott Spring Company. The Davis box lid, manufactured by the Davis Pressed Steel Company of Wilmington, Del., will be used on a large part of this equipment.

New Locomotives.

The New York, New Haven & Hartford Railroad Company has recently placed an order with the Schenectady Locomotive Works for 20 heavy passenger locomotives. They are to be of the American type with 20 by 24-inch cylinders and 73-inch driving wheels with steel centers. The engines will weigh about 134,000 pounds. The boilers are to be 62 inches diameter in the smallest ring, with 312 2-inch tubes 12 feet long. The firebox will be of the "toboggan" type placed on top of the frames and will be 9 feet long and 41 inches wide. The boilers are to have an extended wagon top with radial stays, the dome being on the extension of the wagon top. The maximum travel of valves is to be 6 inches. The guides are to be of the crocodile form, that is, one bar above and the other below the cross-head. The boilers are made very heavy, with butt longitudinal joints, sextuple rivetted. The specifications were prepared by Mr. John Henney, Jr., Superintendent of Motive Power of the line. The engines will be the most powerful of their class which have thus far been built.

The Schenectady Company are also completing five Mogul freight engines for the Maine Central road. These will have 20 by 26-inch cylinders and 63-inch wheels.

Mr. Harvey Middleton, the new Superintendent of Machinery of the Baltimore & Ohio Railroad, has prepared specifications for some new heavy ten-wheeled passenger engines for that line. They are to have 21 by 26-inch cylinders and 78-inch driving wheels, and will weigh about 140,000 pounds. Owing to the short curves on this line the total wheel base of these engines will be only 24 feet 6 inches and the driving wheel base 13 feet 8 inches. The trailing driving axle is under the middle of the firebox, and the other wheels are placed as near together as their diameters will permit. The firebox is also of the "toboggan" type, placed on top the frames and with an extended wagon top and radial stays.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ inches by 6½ inches.
Pamphlets and trade catalogues	3½ inches by 6 inches. 6 inches by 9 inches. 9 inches by 12 inches.
Specifications and letter-paper	8½ inches by 10¾ inches.

Illustrated Price List of Architects, Engineers and Draughtsmen's Supplies. *F. Weber & Co., Philadelphia.* 259 pages, 6 by 9 inches. (Standard size.)

This is an elaborate catalogue, which gives a great deal of detailed information about the materials and instruments used by architects, engineers and draughtsmen, and sold by this firm, but it does not seem to call for special comment.

Catalogue of Pedrick & Ayer Company, *Manufacturers of Special Railroad Machine Tools.* Philadelphia. 105 pages. 6 by 9 inches. (Standard size.)

The tools manufactured by this company include Richard's patent open-side planer, which is made in a number of sizes. Full descriptions are given of this machine and also illustrations showing the kind of work which can be done on them and the method of doing it.

The list of tools of this company also includes shapers, plate-scarfing or planing machine, specially constructed for scarfing steel ship plates, nutting machines, five forms and sizes of which and various attachments for them are described and illustrated. These attachments include universal index-heads, vertical index-heads, vertical or angular attachments, vises for holding work, vise chucks, circular attachments, etc. Following these are a series of illustrations showing how work can be done on these machines with direction for doing it. Among the other tools which are made by this company, and are illustrated in this publication, are universal grinding machines, portable valve-seat votary planing machine, chucks for holding valves while they are being planed, portable crank-pin and wrist-pin turning machines, horizontal boring and drilling machines, cylinder boring and facing machines, portable cylinder boring machine, and various tools, chucks and other devices, to be applied to the machines which the company makes.

Another apparatus is intended for heating, setting and removing tires. "It consists of an oil tank and a furnace, the latter having over the fire grate four retorts; the first three of them for making gas, and the fourth for heating the compressed air. The three gas cylinders are connected together so that the gas in its passage from the first retort, where the oil is admitted, becomes very hot. The fourth cylinder, being in the hottest place, heats the air to about the same temperature." The oil is thus converted into gas and is burned in contact with the tires, being mixed with air in the burners.

Other machines which the company makes are Otto's patent flue cleaner, a jointer for facing brasses of connecting rods, a locomotive lath motion model, etc.

A new department, which has been added to the establishment, is that for making air compressors, pneumatic hoists and appliances used in connection with this class of machinery; the extensive use of which has made it an important branch of the business. Special attention is now given to this department and various new appliances have been brought out.

The catalogue is illustrated by excellent wood cuts, is well printed and has a good index, all of which can be commended.

The Jungfrau Railway.

Competitive plans are desired by the Bureau der Jungfraubahn, Bahnhofstrasse 10, Zürich, for the proposed railway to the summit of the Jungfrau. The sum set apart for the purpose of making awards to the successful competitors is about $6,000. The prizes in question are offered for the best solution of three different groups of problems. The first of these relates to the construction of the line, and plans are desired showing the tunnel profile; the lining, if any, the kind of permanent way and superstructures proposed; the racks, points and switches. The question of electrical power transmission from the falls on the Lutschine River is also included in the first group, together with the designs for the cars, stations, club buildings and elevator from the last station to the mountain summit. The lift of the elevator is fixed at 328 feet, and the shaft is to be 26 feet in diameter, and to be provided with stairways. In the second group of problems proposals are required for methods of executing the work, the driving of the tunnels, removal of spoil, and of precautions for the safety of the men. The third group is concerned with the working of the line, and competitors should deal with the question of maintenance of the way, the electric lighting of the tunnel, cars and stations, and with heating of the two latter by the same agent. Finally, the security of the passengers and staff should also be considered in this connection. Such plans as are sent in will be considered by experts, on whose recommendations the premiums will be awarded. Successful competitors will have no further claim on the committee, as the prize is considered to be considered as payment in full for the use of the premium designs. Unsuccessful designs will be restored to their originators and will remain their private property.

The maximum gradient of the proposed line is fixed at 1 in 4, and the minimum radius of curvature at 328 feet. The maximum width of the cars must not exceed 8.2 feet, and the greatest height

9.84 feet. The speed has been fixed at from 4.3 to 6.2 miles per hour. The water power available is 5,000 horse power effective. The falls are situated at about five miles from the proposed starting point of the line, which will be about 1.5 miles from the tunnel portal. The total length of tunnel will be about 6.2 miles. The latest date for sending in proposals is August 1 next.—*Iron Age.*

The Steam Boiler Plant of the National Electrical Exposition.

The Improved Root Water Tube Boiler, manufactured by the Abendroth & Root Manufacturing Company, of New York, was selected to furnish all the steam used at the National Electrical Exposition, now open in New York, there being two equal units forming one battery of 500 horse power of boilers. The well-known anthracite automatic stoker, manufactured by the Wilkinson Manufacturing Company, of Bridgeport (Montgomery County), Pa., was selected to handle the coal supplied to the fire.

The coal, after being dumped at some distance from the boilers, in the rear, is taken by the C. W. Hunt coal conveyor and carried along the side and a little past the front of the boilers where it is elevated to a point near the ceiling from whence it is delivered through tubes to the hoppers of the Wilkinson Stokers, and, of course, from that point it is fed uniformly down the inclined grates, burning on its way and reaching the foot of the grates as ash, and finally it is dumped into the ash pit below.

The Hunt conveyor next takes the ash and carries it back to a dumping place some distance in the rear of the boiler, dumping it there automatically.

The water of New York City being especially well adapted for boiler use, no filters or purifiers were considered necessary. The pump supplying feed water to the boilers is one of the H. R. Worthington Company's make, and is electrically driven by one of Crocker-Wheeler Company's pump motors: The pump is one of the "steeple pattern," and combined with its motor presents a novel and elegant appearance.

Two of the Root feed-water regulating devices, manufactured by the Abendroth & Root Manufacturing Company, of New York, work in connection with the boilers and feed pump, starting the pump automatically when the water level in the boiler falls below its proper level, and again stopping the pump when the water in the boiler tends to rise above its normal working level.

Thus the entire working of the boiler is made automatic, even to the damper regulation, which is effected by the mechanism made by the Locks Damper Regulator Company, of Salem, Mass.

The entire operation of this plant is so safe and simple that it was decided to put it in charge of a woman to show conclusively that if steam-users will put in the best of everything that the market places at their disposal, and if they will equip their plant properly throughout, it will become so simple in its operation that a woman can operate it as well as the most expert fireman.

The valves used in the main steam piping are especially adapted to high-pressure and ordinary rough handling. They are heavy, straight way valves with an outside yoke and screw and are made by the Chapman Valve Manufacturing Company, of Indian Orchard, Mass.

The pressure carried by the boilers is 125 pounds. This pressure is carried along the main steam piping to a point just beyond the first engine and there it is reduced by a reducing valve to 90 pounds, at which pressure it is carried to all the other engines on exhibition.

At the exhibit of the Ashcroft Manufacturing Company two Edson recording gages will be found in operation, one recording the pressure of steam at the boiler and the other gage recording the pressure on the low pressure side of the reduction valve.

The boilers are equipped with steam gages manufactured by the Ashcroft Manufacturing Company, and with nickel seated pop safety valves made by the Consolidated Valve Company, both of New York and Bridgeport, Conn.

The fine smooth black finish of the boilers is produced by the use of Dixon's Graphite Boiler Front Paint made by the Joseph Dixon Crucible Company, of Jersey City, N. J., whose exhibit will be found in the neighborhood of the boilers. The mason work is certainly of exceptionally fine appearance and is most creditable to the mason, Garret S. Wright, of New York.

The exhaust piping from the 11 engines will probably interest many of the visitors to the Exposition as it has been used by so many electric light companies for this purpose. We refer to the spiral riveted pipe made by the Abendroth & Root Manufacturing Company, of New York.

The battery of improved Root boilers use at this exposition is inexact duplicate to the twelve batteries of boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

The engines on exhibition are all direct connected with generators with two exceptions.

The engines will be found arranged in the following order, beginning with engine nearest to boilers:

The Phœnix engine (the only compound engine).
The Ball & Wood engine.
The Straight Line engine.
The Harrisbugh engine.
The Watertown engine.
The Payne engine.
The McEwen engine.
The Weston engine (belted).
The New York Safety engine (belted).
The Case engine.
The Shepard engine.
The Woodbury Engine.

The exhaust from all of these engines is passed through a Goubert feed-water heater and then sent through the spiral riveted exhaust pipe (placed outside the building) to a point above roof.

All the feed water used will pass through this heater, thus supplying the boilers with a bountiful supply of water heated to near 212 degrees.

Part of the steam pipe covering work is Keasbey & Matteson's magnesia sectional covering, while the other is Gilmour's asbestos covering.

Cast-Iron Wheels in Europe.

Of all the European countries Austria is the only one where the use of cast-iron wheels for railroad purposes is not now prohibited by law, and where, consequently, their manufacture has not been entirely killed. Those laws originated at a time when the make-up of such wheels was far from the present state of perfection as manufactured in the United States.

The general use of these wheels in the United States gave to the manufacturers an opportunity of improving their methods, and to furnish better ones, so that the manufacture of cast iron wheels is to-day a large industry in the United States, and it is said there are more cast-iron wheels manufactured in the United States in one day than in all Europe in one year.

That cast-iron wheels are, nevertheless, well liked wherever they are used is proven by the fact that the Austrian Government, during the past year, asked its representative in the United States, Mr. Fr. von Emperger, Consulting Engineer, 71 Broadway, New York, to make an investigation of the American practice. As a result of this investigation the Austrian Government railways placed an order with a prominent car wheel maker for 120 car wheels of the standard size, for the purpose of using them on freight cars with brakes. The lot has been delivered, but cannot be used elsewhere than within the Austrian boundaries. The reason of this limitation is a rule of the German Railway Union Code, which comprises all central Europe, or at least all the States neighboring Austria. This rule prohibits the use of brakes with cast-iron wheels, and the interchange of cars with cast-iron wheels is therefore impossible, except within the Austrian boundaries, where the railway system comprises some 6,000 miles.

If, by these trials, the European officials can be induced to abolish the above-mentioned rule of the German Railway Union Code there would be a bright prospect for the export of cast-iron wheels to Europe, as the necessary experience and skilled labor, as well as the requisite machinery, cannot be had anywhere in Europe. This trade is, of course, limited to Austria for the present, so far as railways are concerned, and to street railway equipment.

The Bushnell Car Seats.

The eight new passenger cars for the Lehigh Valley's new train between New York and Buffalo, known as the "Black Diamond Express," are all equipped with seats made by the Bushnell Manufacturing Company, of Easton, Pa. The two trains for this service are among the finest ever equipped, and these seats were selected for their beauty and excellence from the samples submitted to the company by competing concerns. They are finished with specially designed mahogany arm rests, and are upholstered in mahogany colored frieze plush.

Since Jan. 1 the Bushnell Manufacturing Company has secured many large and important contracts on both street and steam railways, among which may be mentioned seats for 20 sleepers built by the Wagner Palace Car Company; 20 cars for Detroit Street Railway Company; 10 cars for Akron, Bedford & Cleveland Railway Company; 18 cars for Cleveland, Painesville & Eastern Railway; 20 cars for Milwaukee Street Railway; 8 cars for Lehigh Valley Railroad: 38 cars for Metropolitan Street Railway of Kansas City; 10 cars for Delaware, Lackawanna & Western Railroad; 15 cars for Philadelphia & Reading Railroad, and 30 cars for Broadway Cable Railway, of New York.

The success which these orders indicate is the result of excellence of design in their output, coupled with the high-grade materials employed.

The New York office of the Otis Steel Company has been removed to the Manhattan Life Building, No. 66 Broadway.

Fox Solid Pressed Steel Company have removed their general offices to rooms 1405, 1407 and 1409, in the Fisher Building, 281 Dearborn street, corner of Van Buren street, Chicago.

Mr. James McLaughlin, recently with the Philadelphia Engineering Works, Limited, has been elected Secretary and Treasurer of the Barr Pumping Engine Company, Philadelphia. Mr. W. W. Lindsay is the General Manager of the latter company.

The Diamond Machine Company, of Providence, R. I., are shipping to the Japanese Government a large order for grinding machinery received through their London house. The shipment comprises a large number of articles, including, among others, ten of their large size water-tool grinders.

Carbon Steel Company, manufacturers of acid open-hearth steel, locomotive firebox and boiler plates, and universal plates for bridge and building purposes, announce the removal of their Chicago offices to rooms 1411 and 1413, in the Fisher Building, 281 Dearborn street, corner of Van Buren street.

The Westinghouse Air-Brake Company intend putting a roof over the open space between their foundry and blacksmith shop buildings at Wilmerding. This will give them additional foundry room to the extent of 50 by 500 feet, in which they will erect another system of flask carriers, thereby increasing the output of their foundry from 30 to 40 per cent.

The Continental Iron Works, Brooklyn, N. Y., have supplied four Morison suspension furnaces to the Tuttle Manufacturing and Supply Company, of Anaconda, Mont., three to the International Navigation Company, of New York, for the steamer *Illinois*, and six to Wm. B. Pollock and Company, Youngstown, O. Also several to the Plant Steamship Company, for use on their steamers.

The Franklin Institute, of Philadelphia, after carefully examining into the merits of Cleveland Twist Drill Company's grip sockets, have awarded the firm the Edward Longstreth medal of merit. This action on the part of the Franklin Institute endorses the company's statements, that this grip socket is the best device for holding and driving taper-shank twist drills that has ever been introduced.

The Geometric Drill Company, of New Haven, Conn., has removed to their new factory at 150 Ashman street. The management is in the hands of W. J. Smith, as heretofore. H. E. Adt, who has been connected with John Adt & Son for 15 years, has become associated with the Geometric Drill Company, and will be in charge of the business department. He will also assist in the designing of special machinery.

Judge Dallas, of the United States Circuit Court for the Eastern District of Pennsylvania, filed an opinion on the 6th ult. granting the Ewart Manufacturing Company a preliminary injunction against James H. Mitchell, restraining the latter from the manufacture of an infringement of the plaintiff company's patented chain, which is known as the "Dodge Chain," and which is legally manufactured by the Link-Belt Engineering Company, of Philadelphia, and the Link-Belt Machinery Company, of Chicago.

Mr. E. P. Roberts, Consulting Engineer, and President of the Correspondence School of Technology, Cleveland, O., has been appointed Consulting Engineer for the Port Clinton, O., Electric Light and Power Company. He is also engineer for the Massillon State Insane Asylum, Massillon, O., having charge of the electrical, heating, hydraulic and sanitary work, the latter two departments being taken care of by Mr. E. C. Cooke. Mr. Roberts is also Consulting Engineer for the Columbus State Hospital. All these are new plants on which bids will be called for within the next 30 days.

The U. S. Standard Drawn Steel Company has been incorporated in Ohio, with a capital stock of $50,000, and will manufacture stay bolts and hollow and solid shafting, also weldless tubing of brass, copper, iron and steel, solid cold drawn shapes in steel, and solid and hollow billets. The officers are: President, Samuel A. Sague; Vice-President, L. E. James; Secretary; C. E. Westhafer; Treasurer, C. H. Howland. The works will be located at Cuyahago Falls, O., and the general office in the Western Reserve Building, Cleveland, O. Hydraulic machinery will be used to a large extent in the new plant.

The Erie Railroad Company, after careful investigation, and the consideration of a number of plans, have contracted with the Dodge Coal Storage Company, of Philadelphia, Pa., for a 150,000-ton storage plant at East Buffalo, N. Y. The coal will be stocked in nine divisions or piles, each of about 17,000 tons capacity. The plant will be constructed under the patents of the well-known Dodge system, with the latest improvements, including a complete haulage system for handling the cars. The efficiency of the Dodge system is indicated by the fact that every railroad using it has contracted for a second plant, after more or less extended experience with the first.

Mr. T. F. DeGarmo has been appointed Eastern Representative of the Chicago Pneumatic Tool Company, with office in New York; and William Mack, as Western Representative, with office in Denver, Colo. The company are shipping to Europe three hundred (300) machines of their largest size, and are arranging to open a branch office in London. They have added to their line the Manning Sand-papering Machine, which is meeting with great success, and has proven a great labor saver on coach work; a pneumatic car cleaner for cleaning upholstered seats and carpets in the car and sending the dust through a hose out of the window; and the Manning piston air drill, which is an entirely new machine on the market.

At a meeting of the New York and Brooklyn Bridge trustees, on May 20, the Babcock & Wilcox Boiler Company was awarded a contract for two 400 horse-power boilers for $4,350. The Walker Manufacturing Company, of Cleveland, O., got the contract for two generators of 400 kilowatts, each at $15,849. The Southworth Foundry and Machine Company, of Philadelphia, received the contract for two 600 horse-power engines at $16,400. Twenty passenger cars, 48 feet long, and provided with electric motors, were ordered of the Pullman Palace Car Company, at $3,200 each. The trustees authorized Chief Engineer Martin to advertise for bids for an extension of the power house adequate to receive the additional machinery. This machinery ordered is for the electrical equipment for switching trains at the terminals.

Bids for the machinery and electrical equipment for the new Bascule bridge at N. Halsted street, Chicago, were opened on May 11. The machinery bids were as follows: Vulcan Iron Works, Chicago, $12,956; Chas. Kaestner & Co., $15,845.

The bids for electrical work were as follows: General Electric Company, $7,000; Geo. P. Nichols & Bro., $6,272.50; Vulcan Iron Works Company, $5,379.

The contract for the substructure had previously been let to Wilson & Jackson, Chicago, and for the superstructure to the King Bridge Company, Cleveland. This is to be one the finest equipped bridges in the city, and is to be of the same pattern as the Metropolitan Elevated bridge at Jackson street, which is working so successfully.

In a neat little pamphlet issued by the Standard Paint Company, 2 Liberty street, New York, the method of applying "P. & B. Ruberoid" car roofing is described. This material has as a foundation the best felt manufactured, and this is saturated with the "P. & B." water and acid proof composition. It is a perfect non-conductor, is not affected by changes of temperature, is permanently pliable and elastic, is easily applied and is claimed to have as long a life as the car itself. It is put up in rolls 60 inches wide, each roll containing enough to cover a car. The same material has been successfully used in refrigerator cars between the floors. The "P. & B." insulating papers are also used extensively in refrigerator car insulation, the Merchants' Despatch Transportation Company alone having bought over 1,500,000 square feet of it since Jan. 1, 1895. The "P. & B. Ruberoid" roofing for buildings is put up in rolls 36 inches wide, containing 216 square feet and is claimed to outlast metal roofs. Its use is advocated for round houses, train sheds, boiler houses, etc.

The Pedrick & Ayer Company, 1001 Hamilton St., Philadelphia, who manufacture the well known belt driven air compressors, advocate the use of these compressors "in series," which is accomplished by setting the automatic regulating devices on the machines at slightly different pressures, the lowest one being set at the minimum pressure desired. The others are set between this minimum, and the maximum, so that they take up their work in succession and keep at it until the maximum pressure is reached, each one stopping in turn, and remaining idle until more air is required. This is claimed to be a very decided advantage in installing an air plant. One machine can at first be installed, and when the requirements call for more air, another of the same kind can be attached to the main conveying the air to the receiver, not in any way impairing the utility of the first machine, and this process of adding machines continued as long as the demand for air increases. This plan has the advantage that should any machine become worn and require repairing, that particular machine can be disconnected and not seriously cripple the series. It is urged that even for large plants these belt compressors are economical, as they derive their power from the large shop engine, which is ordinarily more economical than the much smaller steam cylinder of a steam driven air compressor.

Spencer Miller, Engineer of the Cableway Department of the Lidgerwood Manufacturing Company, New York City, has returned from a four months' visit to Europe much improved in health and bringing with him all the American rights under the patents of the Temperly Transporter which the Lidgerwood Company will immediately place upon the market. The Transporter is a hoisting and conveying device employing a suspended beam as a trackway. The chief points in its favor are simplicity in operation, low cost and extreme flexibility. No skill whatever is required to operate the apparatus. About 300 transporters have already been made and the device has therefore passed through its experimental stage. The British Admiralty have adopted it for coaling battleships, having recently purchased nearly 100 of them. Mr. Miller also secured a contract in Paris from the new Panama Canal Company, for seven cableways which were shipped April 30, to Panama. Mr Miller has recently had a patent granted him for a novel form of scoop bucket, which has been thoroughly tested, and has proved entirely satisfactory in loan and sand. It is employed on a cableway. The bucket is lowered to the toe of the sand bank, and the carriage is run ahead so that the draw of the hoist rope is approximately parallel with the slope of the bank and the bucket is drawn up, thereby filling it. If the material be soft the bucket will fill without guidance, but in harder material the bucket has to be guided by a man following it. The bucket is then conveyed back to the place of dumping, and by virtue of lowering the bucket it is overturned and the load spilled. Mr. Miller has also had another patent granted him for a novel form of aerial dumping device.

Messrs. S. T. Wellman, J. W. Seaver and C. H. Wellman announce that they have associated themselves together under the name of the Wellman, Seaver Engineering Company, with offices in the New England Building, Cleveland, O. They expect to make specialties of the following lines of construction. Bessemer and open hearth steel plants, including the most modern furnaces and rolling mills and special electric, hydraulic and pneumatic machinery for the economical handling of material in and around the works: manufacturing and mill buildings of every description, designed with special reference to economical and substantial construction; coal handling and storage plants.

They are the owners of the Wellman Patent Rolling Open Hearth Steel Melting Furnace, which is now in operation at the works of the Illinois Steel Company, South Chicago, Ill., and at the Standard Steel Works, Burnham, Pa. They also own the Wellman patent method and machine for charging open hearth furnaces, in use at both the above works as well as in the Homestead Steel Works of the Carnegie Steel Company, and the Pencoyd Iron Works, Philadelphia, Pa, They own the exclusive right to manufacture the Seaver Patent Coal Elevator.

Complete plans, specifications, and estimates for work will be furnished in any of these lines and they are prepared to take contracts for the same, erected and in working order, or will furnish the drawings and superintend the construction for parties desiring to do their own work. They will act as Consulting Engineers for steel works desiring their services in that capacity. The well-known metallurgist chemist, Mr. Geo. W. Goetz, of 219 Thirty-Fourth Street, Milwaukee, Wis., is associated with the company.

Our Directory

OF OFFICIAL CHANGES IN MAY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Butler & Pittsburg.—F. E. House has been appointed Chief Engineer.

Boston & Maine.—Mr. P. M. Hammett has been appointed Division Master Mechanic, vice A. B. Barrett, at Boston. Mr. D. A. Smith is appointed Master Mechanic of Eastern, Western and Northern divisions, with headquarters at Somerville.

Baltimore & Ohio.—Mr. I. N. Kalbaugh has been promoted to the position of Division Superintendent of Motive Power, with headquarters at Baltimore, vice A. J. Cromwell, resigned. Master Mechanic Thomas Trezise has been transferred to the Pittsburg division with office at Pittsburg and is succeeded at Philadelphia by F. T. White.

Chicago, Peoria & St. Louis.—Mr. F. W. Huidekoper has been elected President, vice Mr. H. W. Putnam, Jr.

Chicago, Lake Shore & Eastern.—C. J. Clifford is appointed Superintendent of Motive Power, and E. B. Smith Master Car Builder, reporting to Mr. Clifford.

Chattanooga Southern.—Mr. H. A. V. Post, of New York, has been chosen President. Mr. Joseph W. Burke has retired from the position of receiver. Mr. M. F. Bonzano has been appointed General Manager, with headquarters at Chattanooga.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. W. A. Bell has been appointed Master Mechanic at Louisville, Ky. Mr. F. J. Zerbee has been appointed Master Mechanic at Wabash, Ind., vice C. H. Doebler, resigned.

Delaware, Lackawanna & Western.—Mr. Wm. S. Sloan, Second Vice-President, died on May 11.

Delaware, Susquehanna & Schuylkill.—Mr. A. J. Beltz has resigned as Master Mechanic at Drifton, Pa.

Delaware & Hudson Canal Co.—Mr. Bernard Vogle has been appointed Mechanical Engineer, with office at Green Island, N Y.

Gulf & Interstate.—W. A. Meagher has been appointed Master Mechanic, with office at Galveston.

Galveston, Houston & Henderson.—Mr. J. H. Hill has been appointed General Manager, with headquarters at Galveston, Tex.

Grand Trunk.—Mr. Adolph Butze has been appointed General Purchasing Agent. Mr. Wm. McWood, formerly Assistant Mechanical Superintendent, has been appointed Superintendent of the Car Department with headquarters at Montreal.

Interoceanic.—Mr. E. V. Sedgwick has been appointed Superintendent of Motive Power and Superintendent of Transportation.

Knoxville, Cumberland Gap & Louisville.—Mr. H. G. Fraser, Purchasing Agent, has resigned and the office is abolished.

Kansas City Belt & Kansas City Union.—Mr. E. S. Washburn has been chosen President, to succeed G. H. Nettleton, deceased.

Louisville, Evansville & St. Louis.—Purchasing Agent H. W. Matters has resigned.

Louisville, Evansville & St. Louis Consolidated.—Mr. Geo. T. Jarvis, Receiver, will also act as General Manager.

Litchfield, Carrollton & Western.—Mr. Joseph Dickson has been appointed Receiver, vice C. H. Bosworth, resigned.

Mexican Central.—Mr. W. Cockfield has been appointed Master Mechanic at San Luis.

Marshfield & Southeastern.—Mr. Chas. H. Grundy has been appointed General Manager, with headquarters at Marshfield, Wis.

Michigan Central.—Mr. E. D. Browner, Master Car Builder, has been appointed Assistant Superintendent of Motive Power, with headquarters at Detroit. Mr. J. T. Hennessy has been appointed Division Master Mechanic at Jackson. Peter Miller has been appointed Master Mechanic.

Norfolk & Virginia Beach.—Mr. O. E. Smith has been appointed Receiver.

New Orleans & Western.—Mr. Chas. E. Levy has been chosen President.

New England.—Mr. J. T. Odell has resigned the position of Second Vice-President and General Manager.

Northern Pacific Railroad.—G. W. Dickenson has been appointed General Manager, with headquarters at Tacoma, Wash. Geo. H. Earle is Secretary to Receivers, with office at St. Paul, Minn. W. L. Darling has been appointed Chief Engineer, with office at St. Paul, vice E. H. McHenry.

Ohio Southern—General Manager A. S. Dunham has resigned.

Ohio River.—Walter Layman has been appointed Master Mechanic, vice A. L. Courtrite, resigned.

Pennsylvania.—J. M. Wallis, Superintendent of Motive Power, is appointed Acting General Superintendent of Division during disability of Superintendent F. L. Sheppard.

Saginaw, Tuscola & Huron.—Sanford Keeler has resigned as General Manager. The President, William L. Webber, assumes the title of that office.

St. Louis, Belleville & Southern.—Mr. W. J. Karner, General Manager, has resigned, and the position is abolished.

St. Louis & San Francisco.—Mr. Aldace F. Walker has resigned as Receiver and Mr. John J. McCook is now sole Receiver.

Wabash.—C. H. Doebler is appointed Master Mechanic at Fort Wayne, Ind.

West Shore.—Mr. J. D. Layng, General Manager, has also been made Second Vice-President.

Employment.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

JULY, 1896.

MASTER CAR BUILDERS' ASSOCIATIO .

Proceedings of the Thirtieth Annual Convention.

The thirtieth annual convention of the Master Car Builders' Association was called to order at Congress Hall, Saratogo, N. Y., June 17, 1896, at 9.30 a. m., President Lentz in the chair. After an opening prayer by a local pastor, Col. H. S. Haines made an interesting address, in which he dwelt at considerable length on the progress in car construction since the days when passenger cars were little better than the cabooses of to-day. He said that the master car builder of to-day must be an engineer, an architect and an artist in order to produce the magnificent, safe and comfortable passenger equipment of to-day. In freight-car construction the great reduction of dead weight in proportion to load, is to be credited to the master car builders and still further progress in this direction is desirable in both freight and passenger equipment. With the high speeds desired to-day, the capacity of the most powerful locomotives is taxed to haul the trains required and if the weights of cars could be so reduced as to enable a locomotive to haul six cars where five are now pulled, the gain would be a decided advantage.

He was followed by President Lentz, who made his annual address. In it he said that in the 12 months from June, 1895, to June, 1896, there had been 100 per cent. more cars built and contracted for than in the preceding 12 months. He congratulated the association on the fact that its standards had been better observed this year than at any time in the past. The code of rules reconstructed on the lines suggested by the Southern and Southwestern Railroad Club would be offered to the association for adoption. One striking suggestion he made was in relation to the decisions of the Arbitration Committee. Last year the committee passed on 330 cases, of which two roads were interested in 19. As these decisions involved much labor and expense he recommended that a road taking a case to the committee should remit with the papers and correspondence relating thereto a check for $10.00, which would be deposited in the treasury of the association.

The secretary's report showed a total membership last year of 372 and at the present time of 388. There are seven additional roads represented in the association, and the total cars represented at present number 1,209,291. The cash received by the secretary during tha year was $8,979. The treasurer's report shows a balance on hand June 11, 1895, of $4,916.22, and on June 16, 1896 ,of $5,509.91.

The dues for the year are fixed at $5.00, as heretofore.

The Auditing Committee was appointed as follows: E. W. Grieves, J. N. Barr, T. Fildes. They reported later that all accounts had been found correct.

Committees on resolutions, nominations and obituaries were also appointed.

Under the subject of new business, Mr. F. W. Lane was elected an associate member. It was decideded to hold two sessions of the convention per day. The formality of a roll call will be dispensed with at future conventions and members requested to turn in their names on cards to be provided by the secretary. The question of the proper loading of logs and rails on cars is so pressing that a committee was appointed to report at a late session of this convention. The committee consists of Messrs. Leeds, Bush, Lewis, Day, Stark, Haskell and Coller.

A resolution strongly endorsing the timber tests conducted by the Forestry Division of the U. S. Department of Agriculture was passed unanimously. The New York Central & Hudson River Railroad extended the courtesy of transportation to members, and the Delaware & Hudson Canal Company tendered an excursion to Lake George for Saturday to members and friends. These courtesies were duly acknowledged.

A letter was read from the Master Blacksmiths' Association, asking that members urge their Master Blacksmiths' Convention be held in Chicago in September. The communication was favorably received and members urged to act in accordance with its request.

Triple Valve Tests.

The reports of committees were next taken up. The first one called for was that on "Triple Valve Tests." The committee is a standing one, and it explained that it had received no valves for test during the year and therefore had no report to make.

Wheel and Track Gages.

The Committee on Standard Wheel and Track Gages, which was appointed to co-operate with a committee of the American Railway Association, reported that certain tests were in progress and that no report could be made at this session.

Tests of Air-Brake Hose.

The noon hour having arrived, topical discussions were taken up, under a rule which allowed ten minutes only to each topic, unless the time was extended by a vote of the association. The first subject was "Tests of Air-Brake Hose." Mr. Barr opened the discussion by stating that he had for some time been testing hose by fixing one end and attaching the other to a moving crosshead which traveled far enough to give the hose an amount of distortion almost sufficient to kink it. Different brands of hose varied to such an extent that the range of endurance was from 200 to 2,800 hours. The hose almost invariably failed near the nipple. While not convinced that this form of test is all that is desired, Mr. Barr is of the opinion the results show clearly that in the effort to make hose that will stand 700 pounds' pressure, the manufacturers have made the hose too stiff and inelastic. He is now trying cotton-covered hose capable of standing 300 pounds air pressure and of much more elastic nature than the common hose. Numerous questions were asked by members, in answering which Mr Barr stated that the failures at the end compared to those in the middle were as 4 to 1. Mr. Schroyer considered that the quality of the rubber determined the flexibility and durability of the hose.

Pressed Steel Trucks.

The next subject was "Pressed Steel Trucks." Mr. Higgins said that there were 90,000 pressed steel trucks in service in this country and that the type had passed beyond the experimental stage. Among the advantages of the pressed steel truck he enumerated the decreased weight, fewer parts, less liability of getting out of square, and improved riding of cars. The saving in weight varied from almost nothing to as much as 2,000 pounds, according to the design of the diamond-frame truck to which it is compared. The fewer parts meant a saving in the cost of inspection and repairs, and the squareness of the truck resulted in fewer sharp wheel flanges and easier haulage. The improved riding of the cars, due in part to placing the springs over the axle-box, is attested by the disposition of the train men to ride on such cars when not in the caboose. The claim for reduced cost of repairs is supported by several cases, in one of which only $1 was spent on these trucks for every $10 expended in repairs to an equal number of diamond trucks. The two kinds of trucks were in the same service, but the pressed steel trucks were only one year old while the others were three years old. The arguments in favor of the diamond-frame truck are the saving in first cost, repairs more easily made after wrecks, greater facility for inspection of wheels, and the ease with which wheels can be changed. Of these the facility for inspection and reduced first cost are admitted, but the experience of Mr. Higgins is that the pressed steel trucks come out of wrecks in better shape, and that it frequently happens that cars so equipped can be hauled from a wreck on their own trucks when diamond trucks are a total wreck. The difference in the cost of changing wheels he also considers to be less than is generally supposed. For large capacity cars, the pressed steel truck seems to be far in the lead. There is, furthermore, a possibility of arriving at a standard truck through this type.

Mr. Sanderson had tried pressed steel trucks in heavy service, and the results were not satisfactory. He does not consider that a modern pressed steel truck should be compared with old diamond trucks, but with the most modern and best designed of that type. The changing of wheels at small interchange points he held to be a difficult matter with pressed steel trucks. Mr. Rhodes called attention to the fact that in modern diamond-frame trucks the number of parts had been generally reduced.

Break-in-Twos.

The next subject discussed was "Break-in-twos." Mr. Waitt started the discussion by stating that he had been investigating the matter on the Lake Shore road and had regular reports of all break-in-twos, whether resulting in damage or not, and he had found that for the first five months of 1896 the number had been 467. This included yard and road service. Of these breakages 45 per cent. were between cars equipped with link-and-pin couplers or where an M. C. B. coupler and a link-and-pin bar were coupled together. Knuckle opening in M. C. B. bars was responsible for 26½ per cent. of the total failures and 21 per cent. were caused by the bar pulling out through either a tail bolt or its key breaking or the latter falling out. The remaining 7½ per cent. of breakages were from miscellaneous causes. Of the failures from knuckle opening he had found most of them due to a bad adjustment of the unlocking gear, there not being slack enough in the chain. He had made it a rule that all coupler chains should have at least 2½ inches slack in the normal position and 3 inches if possible.

Mr. Day said that his road used only the Janney, and he could only speak of that bar, but he had found that the old small unlocking pin never gave any trouble, while the later and larger pin frequently jumped and allowed the coupler knuckle to open. Mr. Sanderson said their greatest trouble was with locks jumping up on M. C. B. couplers on the back end of tenders. Mr. F. H. Soule says that the pin will also creep up. The latest Janney lock gives no trouble whatever. He found the most expensive breakages due to failure of tail pins and that pocket drawbars were all right. Mr. Leeds said that his greatest troubles with the tail pins occured where pins 1½ inches or 1¾ inches in diameter had been substituted in interchange for the regular 2-inch pins. Mr. Rhodes considered manufacturers should give attention to the lifting or jumping of locks, and also to the unlocking of couplers with toggles on the locks that could be operated by a severe shock on the other end of the car. Mr. Barr also receives reports of all break-in-twos on his road and endorsed what had been said about pins creeping up and jumping. He found four times as many failures of this kind in M. C. B. bars as in link-and-pin bars. Mr. Potter said it was the duty of the members to place all available information in the hands of the manufacturers, for the railroads alone had the benefits of experience in the use of the bars. Mr. Bronner said that the experience of the Michigan Central had led them to devote more attention to the maintenance of the unlocking gear. The subject was finally disposed of by making it a subject for a committee to report on next year.

Protective Paints.

A short discussion took place on the kind of paint best suited to the protection of trucks from rust, but Mr. Barr cut it short with the sensible suggestion that as the only trouble occurred from the salt drippings from refrigerator cars, it would be easier to keep the drippings off the trucks than to protect them by paint or japan.

Standards and Recommended Practice.

At the afternoon session the first report to be read was that on the changes in standards and recommended practice. A summary of the report is found elsewhere in this issue, and the recommendations of the committee were endorsed with a few minor changes in wording, and ordered submitted to letter ballot.

Mounting Wheels.

The report on "Mounting Wheels," also published on another page, was discussed briefly, particularly as to the need of the "reference gage," and finally ordered submitted to letter ballot.

The report on "Metal Under Frames for Freight Cars" was read and the discussion postponed until a later session.

THURSDAY'S SESSION.

This session opened by the secretary reading a letter from Mr. R. H. Wilbur, of the Lehigh Valley Railroad, accompanied by considerable interesting correspondence relating to the operation of English railway clearance houses for rolling stock, and the methods of inspecting and interchanging cars in England.

Location of Air-Brake Cylinders.

The report on the "Location of Air-Brake Cylinders on Freight Cars," an abstract of which we will publish next month, was next read. This report advocates that cylinders on all freight cars, where possible, be located approximately under one of the side sills, and many members opposed it in the belief that the rods and levers cannot be made uniform. On the other hand there were several members who appreciated the convenience it affords for repairs and favored the recommendations. The discussion was cut short by the special order of business at 10 o'clock—the rules of interchange.

Rules of Interchange.

Mr. Adams introduced the subject by giving the history of the inception of interchange agreements, and introduced Mr. John Mullen, now President of the Connecticut River Railroad, who presided at the first meeting called for the purpose. He made a brief address. The report of the Arbitration Committee was then read and used as a basis for revision, and as this report was framed on the rules outlined by the committee of 21, the work of revision was, of course, conducted on the lines of owner's responsibility. The entire code as recommended by the Arbitration Committee was passed without change except in two paragraphs, which changes the committee itself suggested. Other changes were proposed by members, but they were voted down with great regularity. The first of the two changes made was the striking out of the clause fixing the responsibility for cars destroyed upon tracks of roads not members of the association, upon the delivering road. The second change was to add a clause to Rule 5 (new code) by which switching roads are made responsible for new defects which occur on cars while in their position, and they are prevented from rendering bills for parts broken on their roads. The prices given in the committee's report were revised by a special committee that reported at a later session. It was also decided that rulings of the Arbitration Committee during the year on points not fully covered by the rules should be in equal force with the regular rules until the end of the year.

The Metric System.

Noon-hour discussions were next taken up, the metric system of weights and measures being the first subject. Mr. Higgins stated that Wm. Sellers & Company had used the system in its injector department for 20 years and did not consider it a success. Several other members spoke against the system and finally the association adopted a resolution condemning any obligatory use of the system, such resolution to be sent to the committees and individuals in Congress interested in the bills which are at present before that body.

Double Buffer Blocks.

The use of double buffer blocks in connection with M. C. B. couplers was next discussed. Mr. E. D. Bronner advocated them, claiming that the cost is about $5 per car and the reduced cost of maintenance of the draft gear will offset this. The horn of the coupler is not suited to take the buffing strains, as it is not in direct line and is not of sufficient area. Properly placed the buffer blocks had not in Mr. Bronner's experience given any trouble in coupling on curves. Mr. Sanderson thought the buffers the cheapest thing available to take the buffing strains. Mr. Rhodes said that before the M. C. B. couplers had been adopted the buffer blocks were used in the East and were only kept off Western equipment because of the prejudice against them, they being known as "man-killers." When the M. C. B. coupler was adopted the Western roads hoped to be able to employ the buffer blocks, but the Eastern lines discarded them at this time, and managers of Western lines quoted this action as a reason why they should not put them on. The C., B. & Q. R. R. decided a few months ago that all its cars with M. C. B. couplers should be fitted with buffer blocks. Mr. Mitchell said that of the 44,000 freight cars owned by the Erie Railroad only about 2,000 cars were without buffer blocks, and it was a very unusual thing to have an M. C. B. coupler head broken off any of their own cars. Mr. Schroyer believes in buffer blocks. Experiments made by him show that a drawbar spring of 20,000 pounds capacity is entirely compressed by a car and its load having a total weight of 40,000 pounds striking a car of the same weight at a speed of four miles per hour. As these speeds are exceeded in nearly every switching movement, the need of buffers is apparent. A vote was passed to the effect that the question of the use of buffer blocks in connection with M. C. B. couplers should be submitted to letter ballot for recommended practice.

Location of Air-Brake Cylinders.

The afternoon session opened with a continuance of the discussion on the report on the location of air-brake cylinders. Mr. Rhodes described some experiments being carried out on the C., B. & Q. R. R., in which a plain tee was placed in the train pipe instead of the drain cup, and the cup itself located at an angle in the branch pipe and so designed that the screen can be readily removed for cleaning. Mr. Rhodes stated that he was not sure of the wisdom of making any change, but gave the description as a matter of possible interest. Mr. Cloud was requested to state the view of the manufacturers in regard to the construction of the drain cup and said that in their opinion the difficulties were overcome by the adoption, about two years ago, of a stronger screen, made of perforated metal. The stopping up of screens only occurred in parts of the surface not in the direct path of the air, and did not become serious enough to prevent action of the brake. As for leading the branch pipe out of the top of the cup, it required several more joints and unless it is a real necessity it is undesirable.

Axle and Journal Box for 80,000-Pound Cars.

The next report to be read was that on the "Axle, Journal-box, Bearing and Wedge for 80,000-Pound Cars," an abstract of which we publish on another page. This admirable report was so complete that it did not admit of much discussion, and after a brief consideration it was decided to submit the designs to letter ballot as recommended practice for one year, and the standing committee on standards were instructed to report on their behavior in service at the next convention, with a view of adopting them as standards if satisfactory.

FRIDAY'S SESSIONS.

Metal Underframes.

The report on metal underframes for freight cars was again discussed, the members having in the meantime visited the various steel cars on exhibition. Mr. Sanderson spoke of the prospect of scarcity of wood in the near future and the tendency toward lower prices for steel shapes as favorable to the prospects of the steel car. He objected to the use of truss rods in steel cars. The greater ability of the steel car to resist the forces of collision is attested by experience with metal tender frames. Mr. Barr said the steel-car question was growing and while the cost was in the way now, the day was coming when it would not be; he therefore moved that five members be appointed, each working independently, to present a design of a steel underframe at the next meeting. This motion was carried and the executive committee will appoint the five persons later. Mr. Bush said that while the cost of the steel cars was now an obstruction to their adoption, the present difficulties would be overcome only by earnest individual effort, and he had therefore promptly seconded Mr. Barr's motion.

Mr. Joughins gave the results of the use of steel cars on the Norfolk & Southern. A sample car built four years ago had not had one cent expended on its frame for repairs. The road had a number of the cars built last year at a cost of from $40 to $50 more than the cost of wooden cars. The weight of the flat cars without brakes is from 19,500 pounds to 20,000 pounds, and the capacity 40,000 pounds. He thinks rivets may be all right but believes that properly fitted bolts are fully as acceptable if not actually better. He does not believe it is necessary to go to patented shapes or construction to obtain a good car. Mr. Stirling, of the Universal Construction Company, claimed that patented articles had contributed much to the progress in railroading, and that there were no serious difficulties in the way of using patented shapes in car construction, as the very existence of the business of a concern advocating such shapes depends on the availability of materials for repairs.

Laboratory Tests of Brake Shoes.

The report on "Laboratory Tests of Brake Shoes" was next read. Before discussing it the report of the joint committee on road and laboratory tests of shoes was read. It stated that present knowledge indicate that on chilled cast-iron wheels in freight service, wrought iron shoes, Congdon, hard and soft cast-iron shoes will give the best service, and at present prices, their economic value will be in the order named. On chilled cast-iron shoes in passenger service, where the pressures and speeds are higher, wrought iron, pressed steel, Congdon, hard and soft cast-iron shoes will give good results and their value is in the order named. For steel-tired wheels no recommendation can be made because the quality of the steel has so much influence on the action of the various shoe metals. The discussion brought out little additional information except that Mr. Barr stated he had found the varying thickness of flanges on cast wheels made it inadvisable to use flanged shoes on those wheels. The committee on brake-shoe tests was made a standing committee.

Passenger Car Ends and Platforms.

The report on "Passenger Car Ends and Platforms" was next presented. An abstract of this report will appear in our next issue. The design recommended by the committee embodied good points from many of the platforms in use at present and in the discussion the committee said that the Eastern Railroad Association had given the opinion that it infringed in some respects on existing patents. The design was therefore presented as representing the best practice, and roads would understand that if they used it they would have to pay royalties on some features of it.

Freight Car Doors.

The report on "Freight Car Doors," published elsewhere in this issue, was next taken up. In the discussion an attempt was made to have the committee continued for another year to present a design of car door and fastenings free from patents and capable of meeting all requirements, with a view of having the design adopted as a standard. A parliamentary tangle ensued which was straightened out by referring the matter to the Executive Committee.

Power Brakes and M. C. B. Specifications.

The noon hour having again arrived, topical discussions were taken up, the first one being, "Will a railroad company be conforming to the law requiring power brakes on cars, regardless of whether its brakes meet the specifications adopted by the M. C. B. Association?" The legal aspect of the question did not receive much attention, but the discussion was most emphatically in support of the resolution with which it closed, and which was proposed by Mr. Mitchell, namely, that "It is the sense of this meeting that brakes whose triples have not met the test of the M. C. B. Association shall not be considered as proper brakes for use on railway equipment."

Pockets vs Tail Pins.

Mr. Hennessey presented an argument in favor of pockets instead of tail-pins in draw-gears. He said that the only arguments for the tail-pin were first cost and ease of removal for repairs; every other point is in favor of the pocket. As showing the greater safety of the latter, he said that of the 27,880 cars on the C., M. & St. P., 95 per cent. were equipped with pocket bars, and in two years only 14 had failed, causing a total damage of $871. In the 5 per cent. equipped with tail-pins, there were 17 failures, costing $2,300. Mr. Mitchell offered a resolution that it was the sense of the meeting that tail-bolts should be abolished, and it was carried.

Mending Air-Brake Hose.

The next topic was the mending of air-brake hose, and Mr. Rhodes produced several samples that had been spliced or in which punctures had been closed with cement, at costs ranging from 7½ cents to 10 cents. As the first cost of the hose is 70 cents the saving is considerable.

Lead Lined vs. Filled Brasses.

A discussion on solid lead-lined brasses vs. filled shell bearings for freight cars brought out the fact that either worked well when properly made, the chief trouble with the shell brass being the small bearing on the axle if the filling is melted out by a hot journal. On the other hand if the shell is rightly made even this difficulty can be overcome. The lead-lined solid brass is evidently the favorite, however.

Substitution of Triples.

After discussing the right of a company to substitute one make of triple valve for another in cleaning or repairing brakes under the interchange rules, it was decided that such substitution is not proper repairs.

Uniformity in Car Construction.

Mr. Soule opened a discussion on the question : "Is it desirable to have greater uniformity in car construction?" He suggested adding to the present standards certain standard dimensions for center plates and side bearings. While not ready for such a step now, the association would also, he thought, find it desirable at some future time to adopt standard shapes for metal underframes, with several standard lengths for each shape. Mr. Peck thought the draft rigging should be standardized, and Mr. Hennessey urged standard sizes of iron for arch bars.

Handholds.

The afternoon session opened with a consideration of the report on "Handholds and Heights of Drawbars." The recommendations of the committee were amended by omitting the handhold in the center of the end of the car, 4 feet 3½ inches above the rail.

Coupler Unlocking Gears.

The report on "Unlocking Arrangements for M. C. B. Automatic Couplers" was next presented and discussed. The report gave considerable information about present devices, but recommended no particular design, and members desired from the committee a design which would meet the requirements of as many couplers as possible. They were consequently instructed to prepare such a design and present it next year.

Stenciling Cars.

The report on "Stenciling of Cars," found elsewhere in this issue, was next received and the recommendations contained in it ordered submitted to letter ballot.

Mr. Leeds, as Chairman of the Committee appointed on Wednesday's session to report on "Loading Poles, Rails, Etc.," presented the report, the recommendations in which will be submitted to letter ballot.

Resolutions of thanks to those who had extended courtesies to the association were carried unanimously. The election of officers resulted as follows: President, S. A. Crone; First Vice-President, E. D. Bronner; Second Vice-President, C. A. Schroyer; Third Vice-President, J. T. Chamberlain; Treasurer, G. W. Demarest; Executive Committee, G. W. Rhodes, P. Leeds and M. M. Martin.

A call for suggestions for the next place of meeting led to the proposal of the following places: Old Point Comfort Niagara Falls, Chicago, Denver, Montreal.

Adjourned.

On May 7 the Michigan Central made a fast run over its Canada Southern division, covering the distance from Windsor to Fort Erie, 229.4 miles, in 3 hours, 34 minutes, 59 seconds, or at the rate of 64.02 miles per hour. One stop was made at St. Thomas, of 4 minutes and 40 seconds, so that the average speed for the actual running time was 65.45 miles per hour. The train consisted of three cars weighing 230,000 pounds, or 115 tons, and was hauled by a 19 by 24 ten-wheeled engine with 68-inch drivers, carrying 160 pounds of steam. The engine weighs 96,300 pounds on the drivers and 27,200 pounds on the truck, or a total of 123,500 pounds.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Proceedings of the Twenty-ninth Annual Convention.

The twenty-ninth annual convention of the American Railway Master Mechanics' Association opened in Saratoga, N. Y., June 22, 1896, President Blackall presiding. After an opening prayer the association listened to an address of welcome from the president of the village. Mr. Blackall then presented his annual address. It was business-like and pointed, and besides touching on the work of the association and of the railroad clubs, dwelt upon some of the advances in railroad practice during the year, among others improved counterbalancing of locomotives, reduction of the weights of reciprocating parts, and rating engines on the tonnage basis. He said that economy had been the watchword with all railroad officials during the year, and a better fuel efficiency is being sought everywhere. Another important matter to which attention is being directed is the improvement in the condition of the men in the employ of the railroad companies.

The Secretary's and Treasurer's reports showed the membership to be 683 and the balance in the treasury $813.34. The Secretary's report called attention to the fact that the association scholarships at the Stevens Institute had not been fully improved, the chief difficulty being that after one year's shop experience (as required by the association) the candidate is not familiar enough with his scientific studies to meet the severe entrance examinations.

The whole matter was referred to a committee that at a later session made a report in which they notified the Association that at the next meeting they would move to amend the constitution by modifying Article 7 to provide that if the scholarships are not filled at the spring examinations by sons of members, railroad employees or sons of railroad employees may compete at the fall examinations.

Another amendment to the constitution presented last year was adopted at this time, by which the Secretary of the association was made an appointee of the Executive Committee. After this action another amendment was proposed for action next year, by which the Secretary is not to be a member of the Executive Committee, and providing for three Vice-Presidents instead of two as at present.

The attention of the association was called to a report of the New York Railroad Commission, in which radial stay boilers were condemned as less safe than crown-bar boilers. The subject was made a special order of business for Tuesday at noon, and the Commission invited by telegraph to be present.

A motion condemning the obligatory use of the metric system was adopted. A resolution endorsing the work of the Master Blacksmiths' Association was passed. Mr. Henderson read a letter from Mr. Bond, of the Pratt & Whitney Company, in which it was stated that the concern had overcome the difficulties in sawing the finest slots in the new decimal gage and would in a few days be ready to deliver the first lot of 500 gages. The Schenectady Locomotive Works invited the association to visit the works. This invitation was accepted and the time fixed for 2:30 Tuesday afternoon.

Exhaust Pipes and Steam Passages.

The first of the reports from committees to be considered was that on "Exhaust Pipes and Steam Passages," a summary of which we publish on another page. This valuable report is voluminous and accompanied by many diagrams, and as none of the members had received any copies of it before coming to the meeting, the discussion was altogether in the nature of interrogations addressed to the committee. The committee was continued for another year with the understanding that a number of roads would be asked to make practical tests of pipes and stacks of the form recommended by it.

Counterbalancing Locomotives.

The report on "Counterbalancing Locomotives," found elsewhere in this issue, was next presented. The Chairman, Mr. Herr, explained that the rule recommended in the report, while undoubtedly correct in principle, should be tested in practice, in order to make sure that the coefficient of $\frac{1}{400}$ of the weight of the engine was best. He said that whether that amount of the reciprocating parts could be left unbalanced or not might be found to depend in a measure on the length of the rigid wheel base and its effect in resisting the lateral swaying of the engine. It might in a similar manner be influenced by the weight on the truck. Mr. W. H. Marshall said that it might also be influenced by the total length of the engine; that there were, for instance, many 10-wheeled engines running weighing from 100,000 to 130,000 pounds, and, on the other hand, many modern 8-wheeled engines of the same weight. The latter were, however, considerably shorter than the former, and the difference in distance from the center of moments of such heavy parts as cylinders at the one end, and foot plates, etc., at the other, would have an effect on the coefficient. Mr. Leeds said that in a number of cases of bent rails he had investigated, the damage had always been done at speed in excess of 48 miles per hour. In each case the engine had the correct total amount of counterbalance, but it was not properly distributed among the wheels, there being a shortage in the main wheels and an excess in the others. After a general discussion on the present practice in counterbalancing, the committee was continued and instructed to make arrangements with a number of roads for practical trials of the proposed rule during the year and report the results at the next convention.

Slide Valves.

The third report to be considered was that on "Slide Valves," which we publish in abstract. Mr. Quereau called attention to the fact that the Allen valve not only had the advantage of the large port opening at early cut-off, but that it was possible with it to greatly reduce the lead, with the result that at a six-inch cut-off the exhaust opening could be delayed about three-quarters of an inch and the exhaust closure delayed nearly one inch, resulting in an increased mean effective pressure of from five to eight per cent. Mr. Herr said that on the Chicago & Northwestern Railway they had been able to add four or five cars to a 40-car train by reducing the lead with a plain valve. Mr. Forney asked if members had found any saving in fuel resulting from the use of the Allen valve. Mr. Forsyth said that he was also interested in that point and was sorry the committee had not considered it in the report. Mr. Vauclain and Professor Goss both testified to the fact that engines were frequently run with too early a cut-off, and that there was no economy in making it less than six inches. Considerable discussion took place on the appearance of some of the indicator diagrams in the report and the fact was brought out that the springing of the valve gear of the average locomotive, made the duplication of results extremely difficult and would probably explain the vagaries in the diagrams.

TUESDAY'S SESSION.

Reciprocating Parts.

Tuesday's session opened with the reading of the report on "Reciprocating Parts," which will be published in abstract in a later issue. The malleable iron piston of the Norfolk & Western Railroad, illustrated in the June issue of this journal, attracted considerable attention. Mr. Vauclain said he had used a somewhat similar piston of cast steel with the bearing ring screwed on. Hollow piston rods were mentioned as a means of reducing the weight of reciprocating parts, but the cost is considerable. Mr. McKenzie called attention to the fact that some of the illustrations in the report showed no shoulders at the taper fit of the rod in the piston head and crosshead. He had not been able to make that construction a success. Mr. Forsyth said that its success depended on the density of the materials employed. If the metal surrounding the rod is soft and ductile, it will stretch and produce a loose fit, but if hard enough the fit will remain perfect. Mr. Thomas, of the Southern Railway, said he had used steel pistons with cast-iron rims cast on to them to obtain a suitable metal for contact with the bore of the cylinder.

Cylinder Bushing.

The report on "Cylinder Bushings," published on another page, led to animated discussion on the best material for cylinder castings. Some members thought that if a strong, tough iron was employed not only the strength but also the wearing qualities would be all that is required, and that the false valve seats and bushings should not be applied to new engines. Cases were cited where engines had run from 14 to 20 years without being bushed. The advocates of bushing new cylinders held, however, that powerful modern engines had given trouble from the breaking of cylinders and saddles and that, when the metal is made strong enough to resist the strains to which it is subjected, it is not found to have as good wearing qualities as in older and smaller engines. The bushings and false valve seats permit the use of a strong metal for the main casting, regardless of its wearing qualities, while these parts can themselves be made of harder and more durable metal than it would ever be possible to use in the main casting. Some cases of reduced fuel consumption on account of the reduction of the friction by the use of hard bushings and valve seats were cited. The cost of bushing is not great, one member saying he could bush a 20 by 24-inch cylinder for $17, and Mr. Vauclain stating that the Baldwin Company's price for bushing the cylinders and valve chambers of a four-cylinder compound locomotive (six bushings) is $125.

Hub Liners.

The report on "Hub Liners" gave several examples of the best current practice. The discussion touched on the babbitting of journal box faces, with which some members had excellent results. Some were in favor of cast iron and others advocated brass as the material for liners. One member uses a liner in two parts bolted together by means of lugs so far from the center of the axle as to be beyond the wheel hub. They clamped firmly on the axle and had the advantage that they could be applied without taking out the wheels. Some members use the liners on new engines, others only in repairs.

Radial Stay vs. Crown Bar Boilers.

The noon hour having arrived, and Mr. Rickard, of the New York Railroad Commission, being present, the question of the relative safety of radial stay and crownbar boilers was discussed. Mr. Rickard read from his report the paragraph that had attracted the attention of the association. It is as follows:

"In the explosions of locomotive boilers, which have taken place in this State, in several years past, many of them have been of boilers with crown-sheets supported by radial stays. While there have been exposions of boilers where the fireboxes have been constructed with crown bars and rivets, the complete destruction of fireboxes in the former type was absent in the latter. Much has been said, and more may be said, as to the relative merits of crown bars and radial stays in such construction. The Board believes this is a subject which should receive the earnest consideration of all persons engaged in boiler construction."

The discussion was almost wholly on the relative merits of the two general types and nearly all of the testimony was in favor of the radial stay boiler. It was shown that instead of the Commissioner's report being in accordance with facts the very reverse of its statements was true, the radial stay firebox often coming down when hot without excessive damage, while the crown bar boiler usually exploded disastrously when the water was allowed to get too low. The Commission had apparently arrived at its conclusions from experience with wide firebox engines, and had not gone into the matter far enough to ascertain whether the trouble was due to faulty construction, imperfect inspection and maintenance, or defects in the general type, but unfortunately these things did not receive consideration in the discussion. The association confined itself to a comparison of the two general types, and terminated the discussion by passing a resolution to the effect that the radial stay boiler is as safe as the crown bar boiler, is easier to keep clean, and more economical in repairs.

Steam Pipes and Joints.

The last report to be considered at this session was that on "Steam Pipes and Joints." The discussion was brief, and did not bring out much that was not already touched on in the report. The report appears elsewhere in this issue.

WEDNESDAY'S SESSION.

The Apprentice Boy.

The first report at this session was on "The Apprentice Boy." This report dwelt chiefly on the possibility of giving apprentices opportunities for instruction in the sciences and the methods to be employed in furnishing the instruction. Mr. Briggs said that employers had but little control over the boys and the trouble was chiefly with the labor organizations. President Smart, of Purdue University, said that Purdue was in a helpful mood, and if there was any work which it could undertake for the better instruction of apprentices it would gladly co-operate with the association. The university is already perfecting the plans for a mechanics' institute, but feels that in the instruction of apprentices it must first find out what was needed. Mr. Forsyth noticed that the committee said they could not recommend an apprentice system. He believes they can, and that they should be requested to report at the next convention an outline of shop instruction and also an outline for technical instruction.

Mr. Miller said that apprentices should be required to come up to a good moral and physical standard, and in dealing with them it should be borne in mind that some were ambitious, and would endeavor to fit themselves for something higher than a mechanic, while others would be content to be good workmen. Mr. Herr said that a proper shop training is the most important consideration, and it appeared to be wholly ignored by the committee. The great question is how can we handle the boys in the shop so that they can most improve their opportunities. Mr. McKenzie said that his practice was to make a careful selection from among the many applicants, and to give each boy a trial of one year at a certain pay. If at the end of that period he had made creditable progress his pay was increased. If his work was unsatisfactory he might be permitted to continue for another year, but if he then failed to make a good showing he was dropped. Mr. Barr though the subject a large one, and believed that the various railroad clubs could discuss it with profit. Mr. Quayle thought it important to advance the boys as rapidly as their ability and efforts warranted, and not discourage them by keeping them on one class of work longer than was right. On the C. & N. W. Ry. he divided app entices into two classes—those with a common-school education, who were carefully instructed in regular shop practice—and those with a technical education, who were given a special shop course, and to whom were also assigned special investigations and other work that would fit them for advanced positions.

Driving Box Wedges.

The report on "Driving Box Wedges" was next considered. Mr. McKenzie believed that stationary wedges to be successful should have wide faces. The frame jaws should be at least 5 inches and the shoes 8 inches wide. He recently had some 10-wheeled engines built with front and back pedestal jaws parallel and the main jaws taper. The greatest trouble with fixed wedges was in the use of shims, there being considerable pound at the boxes before even very thin shims could be inserted. Mr. McIntosh said that the way to overcome that trouble was to fit the stationary wedges when new with shims, say ½ inch thick, and then to have other shims varying in thickness by hundredths of inch. These could be substituted for the original shims when the least pound appeared.

Engine and Tender Steps, Etc.

The report on "Engine and Tender Steps" published elsewhere in this issue was not discussed. The report on "Truck Brake Hangers" had not been printed. It was read, but the members were not, of course, able to discuss it. The report on "Locomotive Grates" was deferred until next year.

Thickness of Wheel Flanges.

The report on "Thickness of Wheel Flanges" recommended: 1. That the minimum thickness of leading engine truck-wheel flanges should be the same for both iron and steel wheels; 2, That the minimum thickness be 1 inch, measured at a point ⅜ inch from the top of flange, as shown on the appended diagram, Fig. 3. In recommending that the steel-flange limit be the same as in cast iron, the fact that the strength of steel admits, with perfect security, of a thinner flange has not been lost sight of by the committee. The recommendation is based purely upon economical considerations as to tire wear.

Some members endeavored to have the convention go on record regarding the safety of a wheel flange ⅞ inch thick, but the association refused to express an opinion, and passed a resolution to the effect that the minimum limit of flange thickness should be 1 inch, and that in the measurement of the flange the M. C. B. flange gage should be employed.

Boiler Tubes.

The report on the thickness of boiler tubes was adopted, and the standard of the association made to conform therewith.

Resolutions of thanks to all who had extended courtesies to the association were passed. The committee on subjects for next year reported twelve subjects, which were referred to the Executive Committee. A resolution was passed recommending that locomotive performance sheets be made out on the ton-mile basis instead of the car or train-mile basis.

The election of officers resulted as follows: President, R. H. Soule; First Vice-President, P. Leeds; Second Vice-President, R. Quayle; Treasurer, O. Stewart. The Executive Committee met after adjournment and appointed John W. Cloud as Secretary.

Mr. John McKenna and Mr. A. Galloway were elected honorary members. A test vote on the next place of meeting resulted in more than two-thirds of the votes being cast in favor of Colorado Springs. Other places mentioned were Old Point Comfort, Bar Harbor, Niagara Falls and Chicago.

Adjourned.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

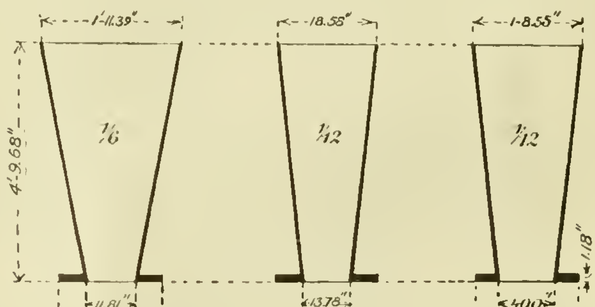
BY INSPECTOR TROSKE.

(*Continued from Page 86.*)

V.—EXPERIMENTS WITH CONICAL STACKS WITHOUT WAISTS.

In order to determine the influence of the waist, similar experiments were made with the three funnel-shaped stacks, that have already been mentioned. Their forms are given in Fig. 37, and they

Fig. 37.



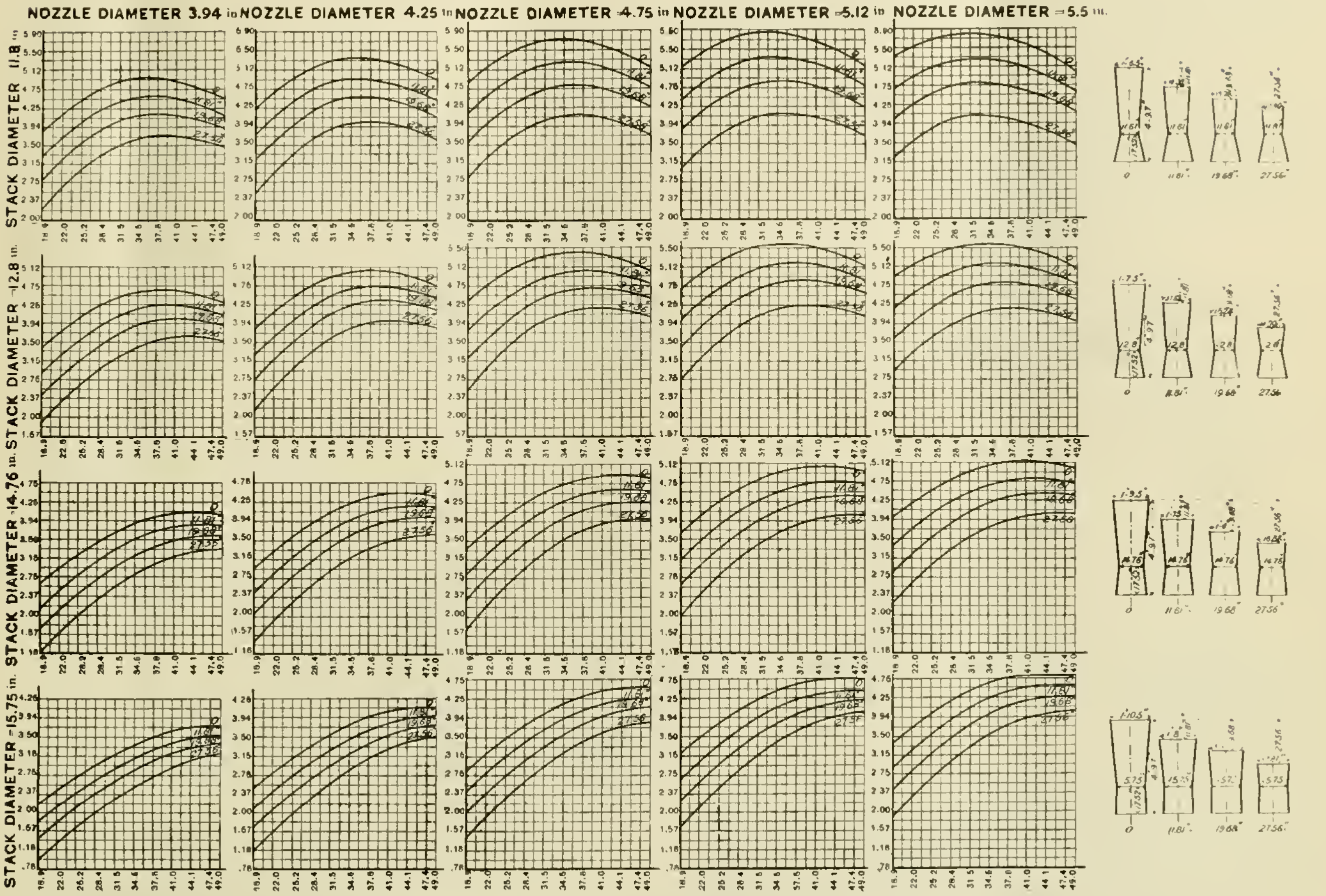
have exactly the same length from the bottom to the top, as the stacks with the waist inclusive of the foot or flare at the bottom, which was 4 feet 9.68 inches. At their lower ends, plates 1.18 inches thick, and 1 foot 6.66 inches outside diameter were riveted, in order that they might be placed upon the rings that have been described. These rings were packed with wicking in this instance also. The shortest distance of the nozzle from the smallest section of the stack was 1.38 inches, and was increased by steps of 1.57 inches to 31.3 inches.

The three stacks were also shortened three times. The results obtained are shown in Plates IV. and V. In these plates, as in Section II., the zero for the abscissas of the nozzle locations is taken from a point 17.52 inches above the lower end of the stack, in order that the abscissa values in all of the plates may be the same.

The most important results obtained with these funnel-shaped stacks are that, when the abscissas on the scale lines ranged from 23.62 inches to 39.37 inches, which means that the nozzle was from 6.1 inches to 21.85 inches below the actual bottom of the stack (that is, from its point of smallest cross-section), the vacuum lines were straight, which means that the vacuums produced varied directly with the increase in the nozzle distance. The relations existing between vacuum, nozzle pressure and nozzle position are here of the very simplest nature. In the diagrammatic representations

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen für Gewerbe und Bauwesen.*

III. SHORTENED CONICAL STACKS WITH AN INCLINATION OF 1 IN 6.



IV. SHORTENED CONICAL STACKS WITHOUT WAISTS

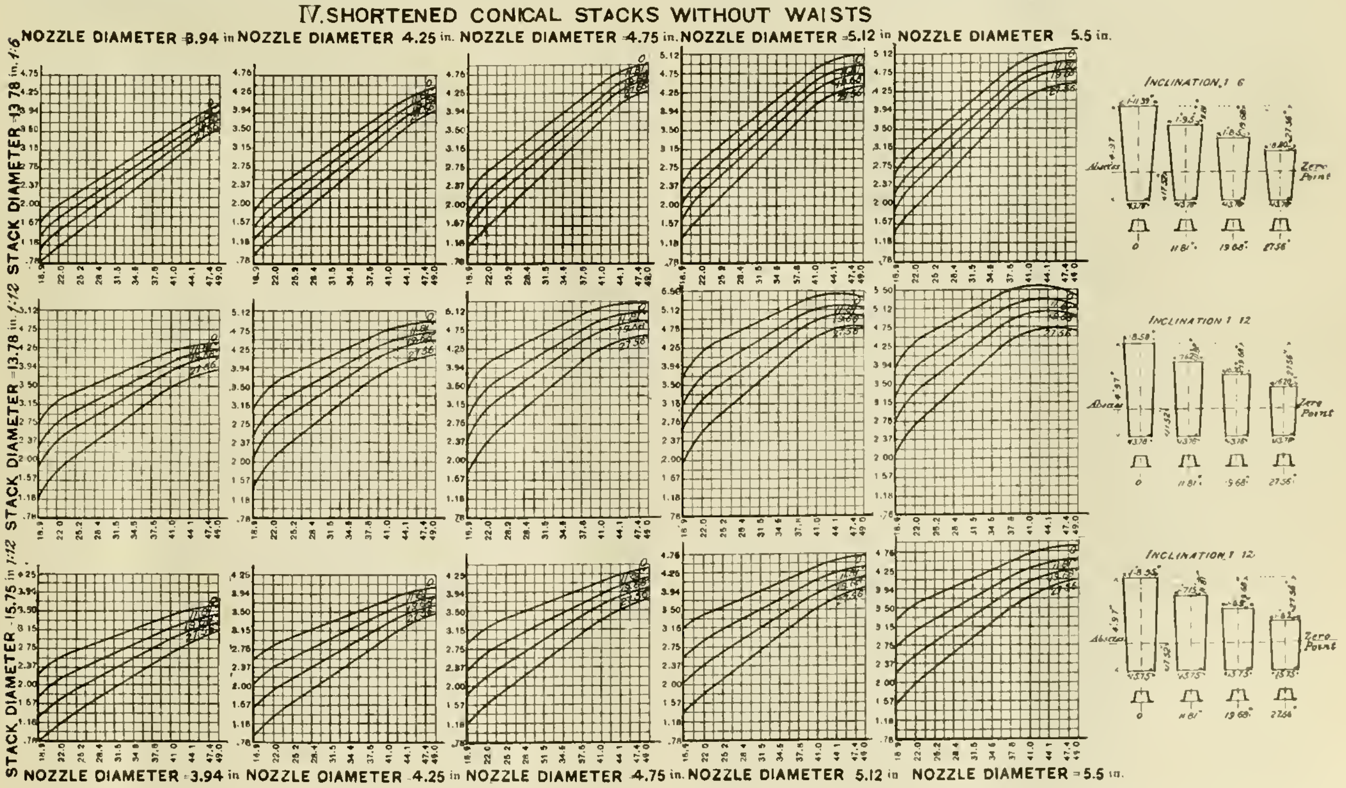


PLATE IV.—DETAIL DIAGRAMS OF THE HANOVER SMOKESTACK AND EXHAUST NOZZLE EXPERIMENTS.

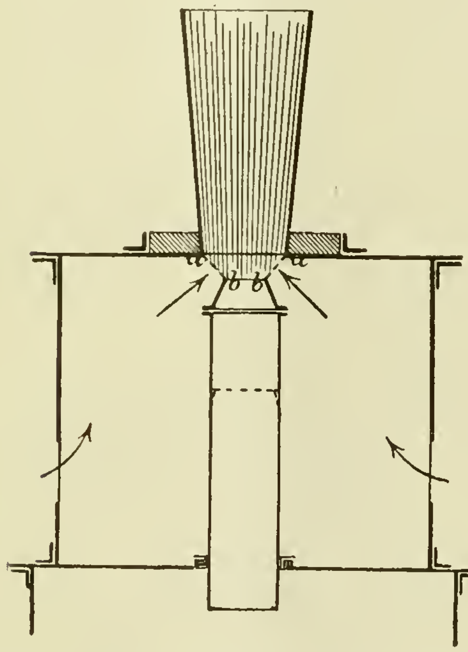
NOTE 1.—The abscissæ (nozzle positions) in stacks without a waist are measured from a point 17.52 inches above the bottom of the stack and 18.90 inches above the highest portion of the nozzle.

2.—The four curves drawn beneath one another are measured from the same base and represent the vacuums produced by the full length stack and the same shortened three times. The amount of each shortening (11.81 inches, 17.68 inches and 27.56 inches) is marked at the right hand end of each.

the first portion of the line, corresponding to nozzle positions of from about 18.9 inches to about 23.62 inches (which is from 1.38 inches to 6.1 inches from the smallest section), curves sharply.

This is because at first, when the distance of the nozzle from the opening to the stack is short, the indraft of air must take place through a small conical opening as shown at *a b* in Fig. 38, which

Fig. 38.



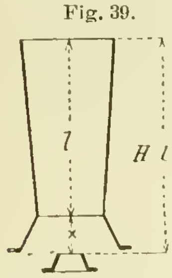
represents a vertical section of the current of steam as it enters the stack. At first, with that nozzle distance, the free section for the admission of air is not large enough to secure a high vacuum without obstruction. In the lines of the diagram in Plate IV. the straight lines are dotted out to the axis of ordinates, in order to show that with a higher vacuum the influence of a small area for the admission of air makes itself felt as well as when the vacuum is lower.

Table XV. (*a*) gives the values of the three principal points of the curve, and, under *b*, the limiting values of the vacuum for nozzle distances ranging from 23.62 inches to 39 37 inches, and consequently those distances between which the vacuum line is straight.

Plate IV. gives the results obtained with shortened stacks. Whence it appears that the straight lines recur in every length of stack that was examined. For the sharpest inclination of stack, namely that of $\frac{1}{8}$, even where the nozzle diameter was only 3.94 inches, the lines of the diagrams are nearly straight though the stack may have been shortened by 27.56 inches. In consequence of the very low vacuum at the outset (only 0.83 inch), the result is, for the reasons already discussed, that the first portion of the curve up to the 23.62-inch. point is likewise straight, but it curves for the slightest shortening of the stack, a circumstance which is also of influeoee with both the other stacks. Plate IV. shows very clearly the very great influence exerted by the position of the blast nozzle on the height of the vacuum. It is also laid down in Table XVI.

Both of these tables show very conclusively how great is the influence of the different locations of the exhaust nozz les upon the action of the draft, and how it can be utilized for the total increase of the same. In order to obtain the figures for a slight increase, we experimented with a funnel-shaped stack. It had an inclination of $\frac{1}{8}$, and its smallest diameter was 13 78 inches, the exhaust nozzle opening being 3.94 inches.

Fig. 39.



With the nozzle down 3.94 inches this stack, which had a length of 4 feet 9.68 inches, gave a vacuum of 1.97 inches as given by the lines of the diagram under IV. in Plate IV. If this stack be shortened 11.81 inches (300 millimeters) at the top, the same vacuum can be obtained by increasing the nozzle distance only 3.15 inches. With the stack shortened 19.68 inches at the top, the nozzle distance must be increased from 3.94 inches to 10.24 inches. In like manner with the total height of the stack lessened by from 8.66 inches to 13.37 inches, the action of the draft remained unchanged:

Now if we reduce both of these shortened stacks back to their first total height, and allow for the original location of the nozzle

TABLE XVI.—SHORTENED STACKS.

(*Conical Stacks Without any Waist.*)

1. Stack Diameter = 13.78 in. Inclination of $\frac{1}{8}$.

		Exhaust Nozzle Diameters.				
		Inches.	Inches.	Inches.	Inches.	Inches.
Length of stack		3.94	4 33	4.74	5.12	5.51
Full Length	Beginning	1.61	1.89	2.17	2.40	2 58
	Maximum	4.09	4.49	4.94	5.12	5.19
Shortened 11.81 in.	Beginning	1.31	1.57	1.81	2 00	2.19
	Maximum	3.91	4.35	4.76	4.92	4.96
" 19 68 in.	Beginning	1.10	1.30	1.50	1.69	1.85
	Maximum	3.80	4.21	4.61	4.74	4.81
" 27.56 in.	Beginning	0.83	0.98	1.11	1.30	1.42
	Maximum	3 62	4.02	4.37	4.48	4.49

Remarks: The starting or beginning value of the vacuum corresponds to the shortest distance of the nozzle below the smallest cross-section of the stack, or 1.38 inches. The maximum likewise corresponds to the greatest distance, or 31.30 inches.

2. Stack Diameter = 13.78 Inches: Inclination of $\frac{1}{12}$.

		Exhaust Nozzle Diameters.				
		Inches.	Inches.	Inches.	Inches.	Inches.
Length of stack		3.91	4.33	4.74	5.12	5.51
Full Length	Beginning	2.76	3.08	3.45	3.70	3.90
	Maximum	4.47	4.92	5 28	5.46	5.59
Shortened 11.81 in.	Beginning	2.28	2.52	2.87	3.13	3 30
	Maximum	4.3t	4.69	5.11	5.20	5 32
" 19.68 in.	Beginning	1.85	2 09	2.42	2.64	2.80
	Maximum	4.17	4 51	4.94	5.02	5.07
" 27.56 in.	Beginning	1.18	1.42	1 73	1.93	2.09
	Maximum	3 90	4.22	4.62	4.79	4 71

Remarks: As in 1, it so happens with the others, that the maximum vacuum is obtained with the 5.12 in nozzle, at an average of 18.15 in. and with the 5.51-in. nozzle at 26.58 in. measured from the smallest cross section of the stack.

3. Stack Diameter = 15.75 Inches: Inclination, $\frac{1}{12}$.

		Exhaust Nozzle Diameter.				
		Inches.	Inches.	Inches.	Inches	Inches.
Length of stack		3.94	4.33	4.74	5.12	5 51
Full length	Beginning	2.22	2.54	2.87	3.15	3.30
	Maximum	3.78	4.16	4.45	4.69	4.82
Shortened 11.81 in.	Beginning	1 73	2.00	2.32	2.5	2.72
	Maximum	3.48	3.88	4.25	4.45	4.57
" t9 68 in.	Beginning	1.30	1 54	1.81	2.00	2 17
	Maximum	3.30	3.70	4 06	4.23	4.35
" 27.56 in.	Beginning	0.79	0.96	1.18	1 38	1.54
	Maximum	3.15	3.52	3.80	4.00	4.13

Remarks: According to this the vacuum appertaining to the stack, that has been shortened 27.56 inches, increases if the position of the nozzle is dropped from 1 38 inches to 31.30 inches, as noted in Remark 2 with Table XVI. This is shown in percentages in Table XVII.

TABLE XVII.

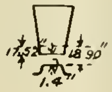
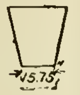
Shape and size of stack.	Diameter of exhaust nozzle.				
	3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.
	Per cent.	Per cent.	Per cent.	Per cent,	Per cent.
13 78 in. $\frac{1}{8}$ inclination	3.38	3.08	2.83	2.45	2.16
13.78 " $\frac{1}{12}$ "	2.30	2.00	1.66	1.47	1.25
15.75 " $\frac{1}{12}$ "	3.00	2.65	2.22	1 90	1 70

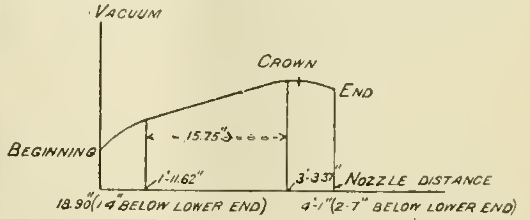
TABLE XVIII.

Nozzle Location, inches.	Total height of stack, inches.	Vacuum, inches.	Increase in the vacuum, per cent.
3.94	57.68 + 3.94 = 61.62	1.97	....
3.94 + 11.81 = 15.75	45.87 + 15.75 = 61.62	2.76	40
3.94 + t9 68 = 23.62	38.00 + 23.62 = .62	3.23	61

TABLE XV.—CONICAL STACKS WITHOUT WAISTS.

(*a.*) Vacuums.

Stack.			Exhaust nozzle diameters. Inches. 3.94	Inches. 4.33	Inches. 4.74	Inches. 5.12	Inches. 5.51	Remarks.
1/8		Beginning	1.61	1.89	2.17	2.40	2.58	1. The abscissas are calculated from a zero point 17.52 inches above the smallest section of the stack, or 18.9 inches above the top of the nozzle.
		Crown	4.09	4.49	4.94	5.12	5.19	2. The shortest distance of the nozzle from the smallet section of the stack is 1.38 inches and the greatest is 31.30 inches.
		End	4.09	4.49	4.94	5.12	5.19	
1/12		Beginning	2.76	3.08	3.45	3.70	3.90	
		Crown	4.47	4.92	5.28	5.46	5.79	
		End	4.47	4.92	5.24	5.39	5.39	
1/12		Beginning	2.22	2.51	2.87	3.45	3.30	
		Crown	3.66	4.06	4.45	4.69	4.82	
		End	3.66	4.06	4.45	4.69	4.82	



(*b.*) Vacuums for Nozzle Distance of from 23.62 Inches to 39.37 Inches (Lines Straight).

Stack Diameter.	Nozzle Distance. Inches.	Exhaust Nozzle Diameters. Inches. 3.94	Difference.	Inches. 4.33	Difference.	Inches. 4.74	Difference.	Inches. 5.12	Difference.	Inches. 5.51	Difference.	Remarks.
13.78 1/8	23.62 39.37	2.17 3.41	1.24	2.48 3.86	1.34	2.85 4.37	1.52	3.08 4.69	1.61	3.27 4.92	1.65	The nozzle distance of 23.62 inches corresponds to a distance of 5.32 inches from the smallest section of the stack, and the distance given as 39.37 inches to one of 21.85 from the smallest section.
13.78 1/12	23.62 39.37	3.35 4.21	0.86	3.70 4.63	0.93	4.13 5.12	0.99	4.41 5.35	0.94	4.61 5.55	0.94	
15.75 1/12	23.62 39.37	2.62 3.35	0.73	2.95 3.72	0.77	3.27 4.09	0.82	3.54 4.39	0.85	3.70 4.57	0.87	

to be increased from 11.81 inches to 19.68 inches (300 to 500 millimeters), the other ratios remaining unchanged, the vacuum will rise from 40 to 64 per cent, as shown in the following table No. XVIII.

This marked increase in the vacuum raises the question as to what is the most advantageous relationship to establish between the length of the stack l and the nozzle distance x (Fig. 39) if the total height H, that is the distance from the nozzle opening to the top of the stack, remains the same.

This question is answered by a reference to the examples given in Plate IV.

Let the smallest stack diameter be 15.75 inches and the nozzle diameter 4.74 inches. The total height of the stack measured from the nozzle is taken consecutively as 5 feet 2.99 inches; 5 feet 6.93 inches and 5 feet 10.87 inches.

We illustrate each one of these latter cases as examined in Fig. 40, and we see:

1. That, with the same total height, the vacuum increases with the decreasing length of stack, the nozzle distance being increased by equal increments.

2. That by increasing the total height the vacuum also increases.

This is not the only case for the stack with a diameter of 15.75 inches cited here, but also for all of the other stacks whose operation is represented under IV. in Plate IV.

From the foregoing, it follows as a matter of course that the stacks should be shortened at the upper end, while the smallest diameter remains unchanged. In this case the sectional area of the stack becomes more contracted relatively to the current of steam and therein lies the reason for the increasing vacuum as the distance down to the nozzle is made greater.

On the other hand, the question arises as to the effect of shortening the stack from the bottom, leaving the sectional area at the top unchanged. For this purpose we have brought together a group of a few stacks from which the curvature plates have been taken; they are shown in Fig. 41, and from them we see:

1. That with the decreasing length of stack and the corresponding increase of nozzle distance, the total height remaining unchanged, the vacuum decreases, and

2. That the vacuum increases again as the total height is made greater.

The decrease is, of course, so slight within the limits of possible practice, that it is of scarcely any importance at all, and may be entirely neglected. From all of these examples it seems that it is advantageous for a locomotive, next to a large stack, as we have already discussed, (*a*) to choose a liberal total height, and of it (*b*) use about six or seven-tenths for the length of the stack itself, and from four to six-tenths for the distance from its base to the nozzle. A rule that will suffice for locomotive practice is to make the total height four or five times the smallest diameter, whereas the former practice has been to make it from six to six and a half times.

From the data given above it will be seen that the nozzle distance should not be made much more than one and a half times the smallest diameter of the stack. As a general thing, we will secure a suitable relationship if we make the stack from 39.37 inches (1 meter) to 47.42 inches (1.2 meters) long above the waist and the nozzle distance from 17.72 inches to 25.59 inches, which is equal to about 1½ d, as shown in Fig. 42.

Fig. 42.

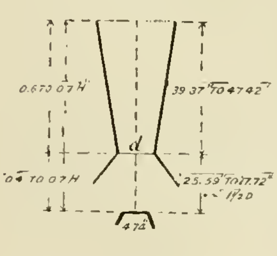
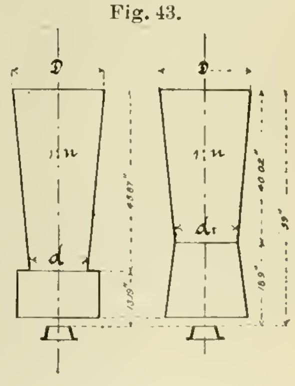


Fig. 43.



The influence which is exerted upon the action of the stack by the means and method of conducting the products of combustion and the steam to it, is shown in the following investigations:

(*a.*) *Suction of the Products of Combustion by the Current of Steam.*

The suction of the products of combustion into the smokebox or air into the apparatus is accomplished in the same way as gas or air would be drawn along by any roughened surface. The inner portion of the stream of steam carries no particles of gas or air with it, so long as it remains closed. Hence the greater the velocity of the steam, or the greater the velocity of the surface of the mantle, by just that amount will more gas be entrained, as is also shown in Section VIII.

Fig. 40.

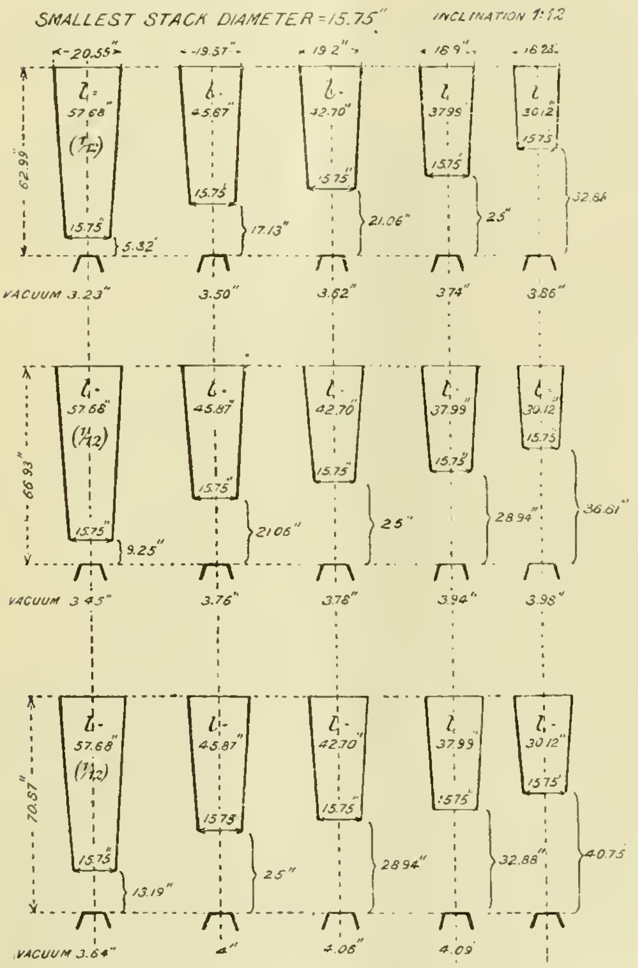
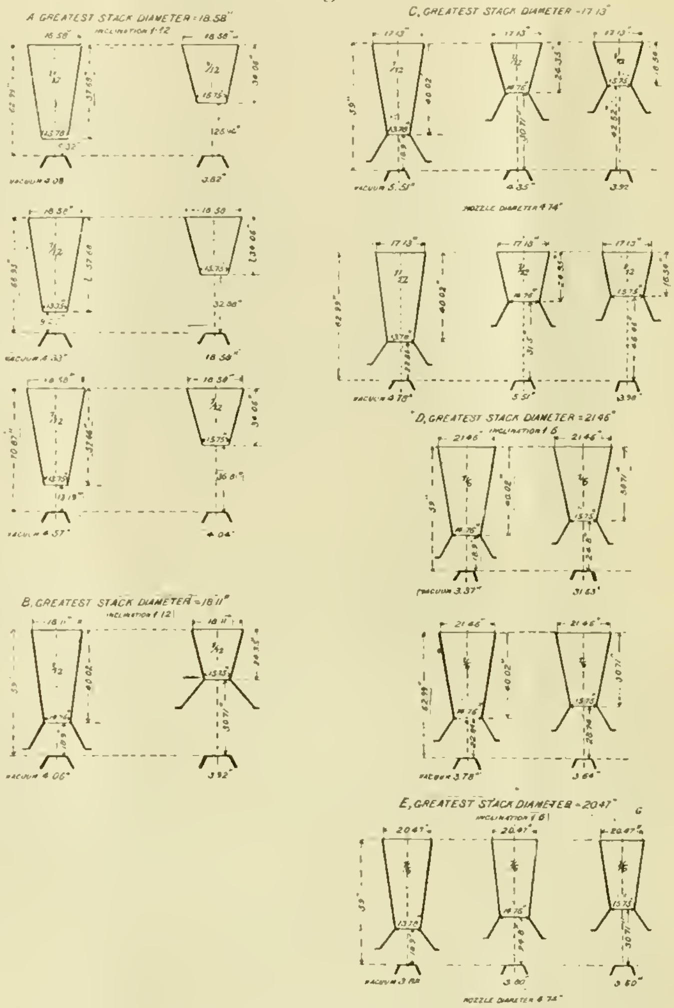
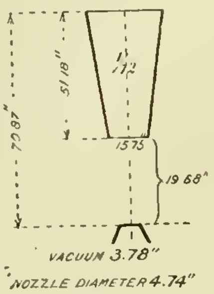


Fig. 41.



(b.) Shape of the Foot of the Stack.



What influence does the shape of the foot of the stack exert upon the vacuum? As the result of experiments, the cylindrical, the conical and the conico-cylindrical shape ol stack came to be applied. So, in order to learn the influence of each, we make a comparison.

1, between the funnel-shaped and the waist-shaped stack;

2, between the full length and the stack shortened at the top, wherein the two stacks exactly corresponded at their upper ends, and were of a given length.

Fig. 43 shows two of these stacks haviog a having a total height of 4 feet 11 inches which for the last 3 feet 4.02 inches of their upper ends are exactly alike. The vacuums obtained with stacks of different diametersand inclinations, with nozzles of 3.94 inches and 4.74 inches in diameter, are shown grouped together in the following table XIX.

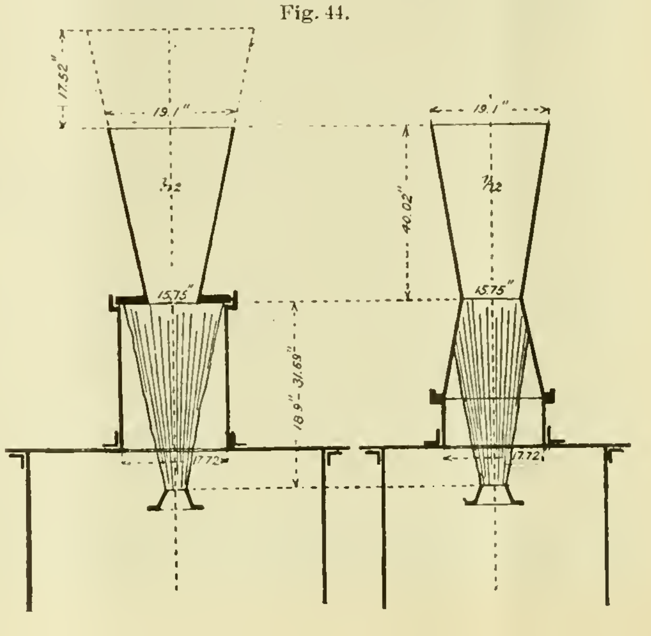
TABLE XIX.

			Vacuums with	
			Tunnel-shaped stacks.	Stacks with waist.
	Inches.	Inches.	Inches.	Inches.
Inclination $\frac{1}{6}$	D = 21.42, d = 13.78, d_1 = 14.72	nozzle diameters = 3.94	2.48	2.58
		4.74	3 23	3.37
Inclination $\frac{1}{12}$.	D = 17 60, d = 13.78, d_1 = 14.25	nozzle diameters = 3 94	3 39	3.45
		4.74	4.17	4.29
Inclination $\frac{1}{12}$.	D = 19.57, d = 15.75, d_1 = 16.22	nozzle diameters = 3.94	2 58	2.60
		4 74	3.27	3.35

For grea'er nozzle distances than these shown in Fig. 43, there is a similar correspondence, as shown by the lines of the diagrams.

Another example is clearly shown in Plate III. Here a full length waist-shaped stack with an inclination of $\frac{1}{12}$ and with a min'mum diameter of 15 75 inches is compared with a funnel-shaped stack of the same minimum diameter, but from which 17.52 inches have been taken from the upper end. Both stacks are, therefore, the same length from their point of smallest cross-section to the top. They should then, according to the foregoing, give practically the same values for the vacuums obtained with

Fig. 44.



them. If we now combine the corresponding co-ordinates of the funnel-shaped stacks from Plate IV.(abscissas 3 feet 0.42 inches to 4 feet 1.19 inches),with those of Plate III.(abscissas 1 foot 6.9 inches to 2 feet 10.65 inches) we obtain as the points of the curve those shown by the dotted curve given in connection therewith.

The latter lie, in all five cases, below each of the waist-stacks, but the actual difference is not really as great as one would be led to think from the diagrams. But we must consider that there were several observations that were known to have been erroneous, that there were many interruptions to the work, and that some slight inaccuracies in the reproduction of the curves have crept in. In figures the values for the abscissa of 18.9 inches with a nozzle diameter of 3.94 inches are, for funnel-shaped stacks, 2.72 inches; for waist shaped stacks 2.82 inches.

When the nozzle diameter is 4.33 inches these values become 3.05 inches and 3.17 inches. When the nozzle distance is about 27½ inches from the smallest portion of the stack, the difference, as shown in Plate III, is greater, though still insignificant. From this it appears to be certain that, with a nozzle distance of about 27½ inches. a continuous current of steam, like that shown in Section VIII., which deals with the "shape of the steam current," begins to fill the whole sectional area of a stack that has a diameter of 15.75 inches, and that, at a greater distance, it strikes against the foot of the stack; that is to say, with the funnel-shaped stacks it strikes directly against the ring at the bottom, while with those having a waist, it impinges against the sides of the flare at the bottom. Both cases are clearly shown in Fig. 44. In the first case there must naturally be a somewhat more vigorous impact and a greater contraction at the smallest cross-section than with the waist-shaped stack, as well as a corresponding f the vacuum indicated.

[TO BE CONTINUED.]

Communications.

The Metric System.

Editor American Engineer, Car Builder and Railroad Journal:

In your April issue, page 59, I find an interesting article on the "metric system." It is true that the larger part of European governments have adopted that system, and in doing so have made progress from the confusion in weights and measures existing in former times. But now that we are intimate with all the peculiarities of the system, we are able to see its various faults, principally arising from the unfortunate choice of units. These units are scientifically derived, but not adapted to the daily work of many people. Their only advantage is in the use of the decadal division. but for the exigencies of practical trade these units are not adapted.

Furthermore, in the metric system only the factors of measure and weight are in good arithmetical connection, while the experience of modern times demonstrates that the factors of *value* and *time* should not stand aside; they are to be fellows of the closed ring—measure, weight, value and time. For all this, though being a condition of progress in the expansion of modern trade, there is no room in the metric system, and, as the world progresses, we see that the metric system is not at all to be the final one. If your country wants to take in hand the heavy work of changing your units for others, these ought to be of a real international character you want a system and units whose practical qualities are much superior to those of any system which has thus far been used anywhere, in order to be accepted for its advantages by other people. This also will be the shortest way to arrive at an international understanding about these things and not by substituting any defective system by another one.

I inclose a short sketch of an international system which might suffice for all scientific and practical purposes. WILHELM BOSSE,
Vienna VII., Burggasse 2, Austria

[Herr Bosse urges, in his circular, that the four factors of dimension, weight, value and time should be based upon some system of the utmost simplicity that is practicable, and should also be connected with one another in a manner that is clear and devoid of complication. In order to accomplish this he starts with his measure of length. In this he would take as the unit the equatorial circumference of the earth and divide it into 1,000 geographical degrees, and then sub-divide each one of these degrees into 10 miles, so that a convenient measure of length would be obtained, and one which could readily be used as a basis of the measure of time. For a practical working dimension this mile should be itself divided into 10,000 feet, two of which feet would be equal to the usual step. Further subdivisions would be on a decimal basis. For cubic capacity, the unit would be a cubic foot, divided into 100 parts. The size of the latter corresponds quite accurately with the ordinary wine measures used all over the world. The unit of weight is also based upon the cubic foot, and should be the weight of a cubic foot of water, and is only slightly heavier than the centner used up to the present time. The subdivisions to follow would naturally be into 100 pounds. For value, Herr Bosse assumes that the relative value of gold and silver to be as 20 to 1. On this basis he proposes an effective weight of $\frac{1}{100}$ pound of $\frac{9}{10}$ fine fine gold, whose value would be about 20 francs as a basis, and on the same hypothesis $\frac{2}{100}$ pound of $\frac{9}{10}$ fine silver would represent two francs. This is recommended as the international unit of value.—EDITOR.]

Discussing Rail Specifications.

At a recent Pittsburg meeting of the officers' association of the Pennsylvania Company, attended by representatives of the lines and branches west of Pittsburgh, the principal topic of discussion was the chemical composition of the steel rails used on the Pennsylvania system. While it was conceded that the character of the rails laid has shown some improvement in recent years, it was also brought out in the discussion that there had been more breakage than the management wanted to see in the past year. The drift of sentiment was toward a specification for lower phosphorus. No formal action was taken, and we are advised by an officer of the road that the matter is simply being investigated with a view to obtaining as much light as possible on the subject. It is not definitely determined, indeed, that any change from recent practice will be made.

The expressions at the Pittsburgh meeting, however, are in line with the new specifications for steel rails presented by Robert W. Hunt at the Atlanta meeting of the American Institute of Mining Engineers last October. Capt. Hunt made the point that whereas the Western mills had been allowed 0.11 per cent. phosphorus in their rails, and in some cases 0.12 per cent., it was now practicable, in view of the vast deposits of low phosphorus Mesabi ores, for these mills to bring the phosphorus in their rails below 0.09 per cent. The new specification which he presented, therefore, called for not to exceed 0.085 per cent. phosphorus, and silicon not below 0.10 per cent. The specified range in carbon was not below 0.43 per cent. and not over 0.51 per cent. for the 70-pound section; not less than 0.45 per cent and not over 0.53 per cent. for the 75-pound section; not less than 0.48 per cent. nor over 0.56 per cent. for the 80-pound section; not less than 0.55 per cent. nor over 0.63 per cent. for the 90-pound section; not less than 0.62 per cent. nor over 0.70 per cent. for the 100-pound section.—*Iron Trade Review.*

The Limit of Elasticity.

In an interesting article in *Science Progress* on the "Mechanical Testing of Iron and Steel," Prof. Hudson Beare has the following to say on the limit of elasticity :

"No term has given rise to more confusion in dealing with the strength of materials than this. One instance will suffice to show the kind of error produced by false notions as to its meaning; the well-known fact that by stressing a bar in tension beyond its yield point we raised its limit of elasticity in tension, was usually considered to represent the whole result of the action. We know, however, from the researches of Bauschinger that this is a very imperfect and misleading conclusion—a conclusion, too, which may have caused much of the difficulty in understanding some of the results obtained in the endurance tests of Wohler. Bauschinger's experiments, carried out with perhaps more exactitude than any previous experiments of this nature, lead us to conclude that there is for any given material a true natural limit of elasticity, understanding by that term the limit of the elastic condition according to Hook's law, *ut tensio sic vis.* But this natural limit may be varied in all sorts of ways—by strains set up in the material during manufacture, by after working, or in a testing machine. Unless, therefore, we know the whole previous history of the bar we are testing, we are quite unable to say whether the limit obtained in our test is a natural one, or whether it is some artificial one produced by some treatment the bar has undergone. In one form this fact was appreciated by all those interested in the question of testing. It was well known, for example, that cold rolling greatly raises the limit Two bars rolled from the same ingot would give very different values for this factor, the one with the smaller cross-sectional area—and, therefore, during the last stages of manufacture rolled while partially cold—would show a much higher apparent limit. But it was not, at any rate, generally understood that such effects were only particular cases of a much more general law. This fact at once disposes of the talk often indulged in during discussions on this subject as to the value of high elastic limits when they are determined simply from a static tensile test; and the importance of the question is at once realized when we consider that these so-called higher values are made the basis of a claim for higher working stresses, even for cases where the loads are alternating tension and compression. It is to be hoped, therefore, that this question of the determination of the natural limits of elasticity of different qualities of iron and steel will be undertaken as a research work by some competent observers having the requisite delicate measuring apparatus at their disposal. Such a research, if carefully carried through, would settle many important points of the uttermost pr ctical value, and would, at the same time, confirm experiments which, from their far-reaching consequences, and from the fact that the deductions from them depend on extremely small differences in measurements themselves very minute, much need confirmation. Carried out in a systematic manner, careful chemical analysis being made of the material tested, we should obtain data to make it possible to deduce the relations existing between the values of the natural limits, and the proportions of the various constituents of other elements present in iron or steel, and probably be able to ascertain definitely the best proportions for a material required for some given purpose. It would also enable us to settle in a much more rational manner the working stresses which could be allowed in any given case; this, a matter of the utmost consequence in the case of parts of machines or structures subjected to alternations of stresses, is equally of importance where there are only variation of stresses or even only long continued statical loads. for we are still without information as to the changes which may go on in the value of the limit under these conditions. That a steady change in the opinion of engineers in regard to this question of working stress has been in progress for the past few years is undoubted, but at present we are still groping more or less in the dark, because, though there is a mass of rapidly accumulating data, it at present seems largely to be only capable of being used in a more or less empirical fashion, and still to be in need of some rational explanation. The researches of the Committee of the Institution of Mechanical Engineers on "Alloys' has no doubt done something to shift the question into a clearer light, but the field open for research is still very wide.

Kindling Locomotive Fires on the Norfolk & Western Railroad.

At a recent meeting of the Southern & Southwestern Railway Club Mr. R. P. C. Sanderson, of the Norfolk & Western Railroad made the following statement in relation to locomotive fire, kindlers:

It is only recently that much has been heard about kindling fires of locomotives by the use of oils instead of cord wood or waste wood from the car shops, and much mystery and many patents have been in evidence since then.

To ascertain just exactly how much benefit and economy was to be achieved by discarding wood for kindling fires and introducing the use of oil, experimental apparatuses of different kinds were prepared at some of the shops of the Norfolk & Western Railroad, and after a few months of experimental use, with varying success, it was found that the economy by the use of oil as compared with firewood was very great, and pressure was then brought to bear on each of the shops to see how little oil could be used for this purpose.

In the first devices experimented with, crude or fuel oil was employed, as it was thought that the greater calorific properties of crude were decidedly beneficial. As it was a great inconvenience to carry the small quantities of this special oil in stock at points where cheap black oil used for lubricating cars was carried in storage tanks, the use of crude oil or fuel oil was soon abandoned and lubricating oil used, with a small addition of kerosene to make it more inflammable. Subsequently it was found that the addition of kerosene was quite unnecessary and that the lubricating oil was sufficient in itself.

It was then found that by establishing some rivalry between the different shops the quantity of oil used could be steadily reduced until the cost per engine for a month's firing-up had dropped to one and one-fifth cents per engine. Subsequent to this it was further found by one of our master mechanics that the oil was entirely unnecessary, and that by heaping up lump coal in a mound a short distance from the inside of the fire door and by throwing the usual handful of greasy waste (discarded by the wipers) on the face of this coal pile, setting fire to this waste, and then directing a jet of compressed air directly on this small handful of burning waste, the flame from it can be driven right into the coal pile, and that in the course of four or five minutes, or possibly a little longer, according to the condition of the coal and the pressure of the air used, the mound or heap of coal can be brought to a good red heat ready for spreading over the grate bars without the use of any oil whatever. This plan has been found to be successful with the Pocahontas coal, Clinch Valley coals, and Thacker and semi-splint coals used on the Norfolk & Western Railroad, which vary widely in their nature, and it is believed that this same plan can be followed with any coal that is not too hard or slow burning in its composition.

I do not wish to say that we do not now use any oil for firing up, because we have found that with the use of a little oil in with the compressed air, it will hurry up matters a little in cases of emergency.

The majority of the engines fired which are referred to have large fireboxes 10 feet or more in length, and at most of the engine houses the boilers are filled with hot water, and in this way considerable economy in time in firing up and getting engines ready for service has been accomplished without any injury to the boilers.

Where nothing but air is used to ignite the coal, it will be found ordinarily that it does not pay to handle the scrap wood from the car repair tracks or the old ties or bridge lumber, as the cost of cutting it up and handling it is greater than the small amount of coal consumed in compressing the air, and to get rid of this old material it is found to be more economical to sell it as firewood to the employees and public at a small price, or to burn it up in heaps where it lies, if it cannot be got rid of in any other way.

We take from the discussion of Mr. Sanderson's statement the following:

Mr. Gentry—Mr. Sanderson does not say how much coal is used. I don't suppose much of it is consumed. I take it that it don't take very much more coal than where wood is used. I saw one experiment made at Alexandria by Mr. C. F. Thomas, and it didn't strike me that very much coal was consumed during the process of ignition.

Mr. Hudson—My experience has been that it takes very little more coal to kindle with oil and coal than it does with wood and coal. I find that fires can be kindled with a great deal of economy without using any oil at all by simply putting in a small quantity of waste, and using the steam blower on the engine. We fire about as many engines without oil as with oil, and there is no injury to the flues or sheets. There is practically no difference in time with or without oil.

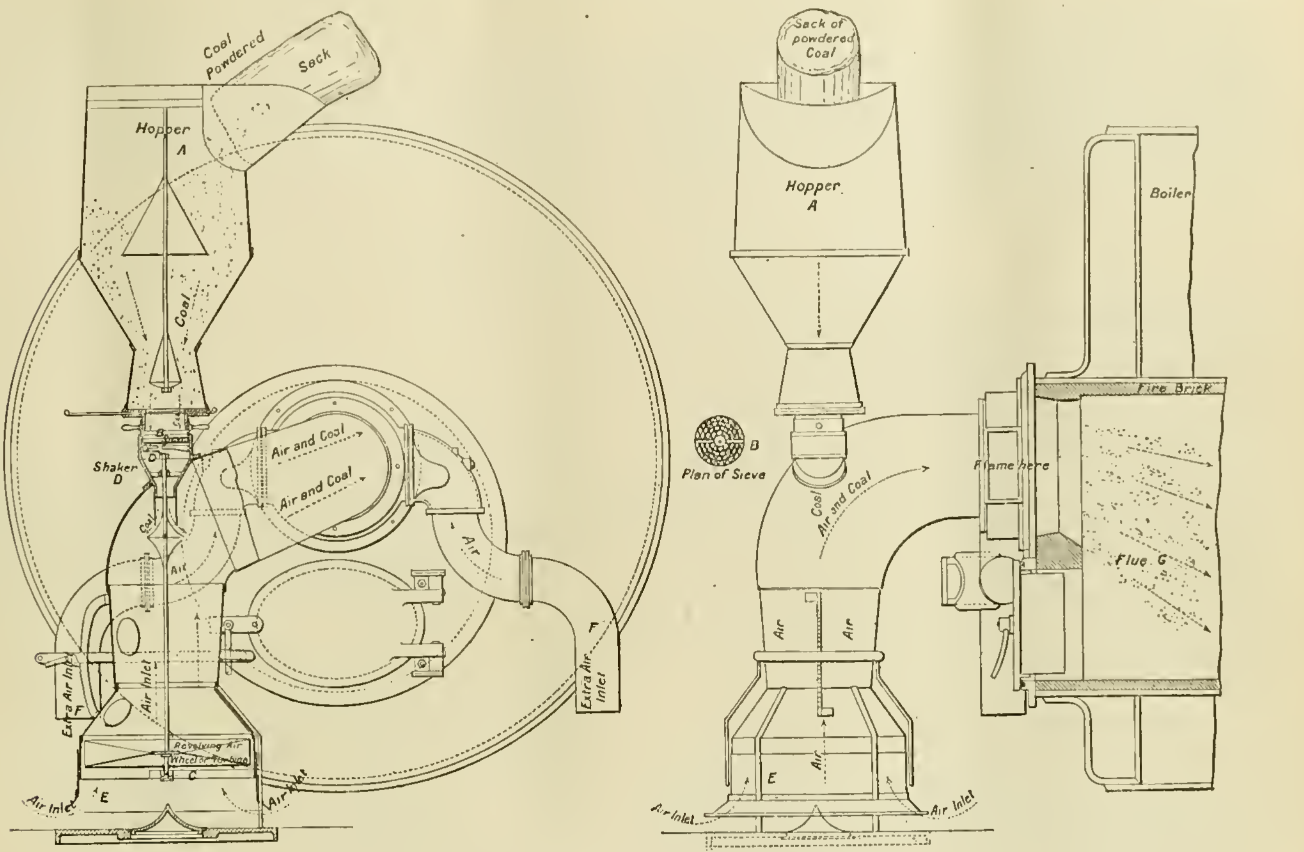
T. W. Gentry—It was not necessary for the parties I referred to to go to any expense in the way of a new plant. They utilized what they had at hand, which was an old boiler, to fill the engines with hot water. Anybody who has an air pump can utilize it. It is not much of an item with a few engines. The experiment I have seen was in a large engine house, where everything was at hand. They just used the blower and the dirty waste.

Mr. Anderson—I remember making one experiment in kindling fires with dirty waste, in which it took within a few pounds of 500 pounds of coal to get 65 or 70 pounds of steam. I did not use any wood, and we got steam up in about 55 minutes. I have not used any wood for over two years; we kindle all our fires with waste that has been used to wipe with.

Wegener's Apparatus for Burning Powdered Fuel.

The accompanying engraving, reproduced from the *Engineer*, illustrate a new form of apparatus designed by Herr Wegener for burning finely pulverized coal, and burning it in such a way that the quantity is automatically varied with the quantity of air admitted for supporting combustion. The apparatus has been in use some time in Europe, and is now in use in the works of Messrs. Bryan Donkin and Co., London, England.

Our engraving shows the apparatus in detail as applicable to any boiler. The small sacks of powdered coal, weighing about 50 pounds



The Wegener Powdered Fuel Apparatus for Boilers.

are put into a conical hopper *A*: The powdered coal gradually falls out of the sacks as required into the hopper, and then on to a sieve *B*, about 5½ inches diameter, with small openings in it. The powdered coal would not continue to pass through this sieve with certainty without continual tapping, and this is done in the following way:

Immediately beneath the hopper, and level with the boiler-house floor, is an air pipe *E*, about 20 inches diameter, through which nearly all the air for combustion enters. As it enters it is made to pass through the blades of an air-wheel or turbine *C*, and this passage of the air causes the latter to revolve like a smoke-jack. On the axis of this air-wheel there is a little knocker which taps the sieve from 150 to 250 times per minute, causing the powdered coal to descend vertically through the sieve, meeting the air for combustion as it ascends vertically. The powdered coal and air for proper combustion in this way get mixed thoroughly together and pass on into the boiler flue, each particle of coal being surrounded by air. There is no grate and there are no fire doors, and the stoking simply consists of putting a sack of powdered coal from time to time into the top of the hopper, and seeing that the right amount of air is going in for combustion. If there is not sufficient air for proper combustion entering through the main opening, as shown by a little smoke, there are two other smaller pipes where additional air can be admitted, each kind of coal requiring a somewhat different amount of air. The only object of the air-wheel revolving from 75 to 125 revolutions per minute is to shake the sieve and cause the powdered fuel to go into the furnace in the quantity desired. When more steam and coal are required a greater knock is given to the sieve, and more powdered coal is burned; when less is required a less shake is necessary. A screw adjustment for this knocking device is provided to regulate the amount of coal entering, which is done by turning a thumb-screw. The attendant can look after several boilers. An analysis of gases of combustion proves that the combustion is excellent and the amount CO_2 is higher than with ordinary furnaces.

Mr. Bryan Donkin made a careful test on a Cornish boiler, at Berlin, in March last, first, with an ordinary grate and ordinary hand-stoking; and, secondly, a few days after, on same boiler, same conditions, and same coal, but with Wegener's patent system of powdered or molecular firing.

The following table gives the results of the experiments:

RESULTS OF TRIALS.

Trial.		
Experimental number	I.	II.
Date of experiment, 1895	March 29.	April 1.
Conditions, with or without Wegener's apparatus	Without	With
Duration of trial, continuous, hours	7.1	6.66
Weather	Wet	Fine and dry
Mean steam pressure (from tested Bourdon gage every quarter hour), lb	82	83.4
Coal.		
Total coal burned, lb	1,606	1,410
Coal burned per hour, lb	225	211.5
Coal burned per hour per sq. ft. of fire-grate, lb	16.3	....
Moisture in coal, per cent	9.0	1.2
Ashes and clinkers in coal, per cent	11.8	Assumed at 15 to 19
Water.		
Mean temperature of feed water entering Boiler, Fah	63°	48.2°
Total feed water evaporated, lb	7,928	10,517
Water evaporated per hour, lb	1,117	1,577
Water evaporated per hour per sq. ft. heating surface, lb	2.23	3.15
Evaporation.		
Lb. water evaporated per lb. wet coal, from temperature of feed, lb	4.956	7.16
Lb. water evaporated per lb. wet coal, from and at 212 deg. Fah., lb	5.90	9.00
Lb. water evaporated per lb. dry coal, from and at 212 deg. Fah., lb	6.18	9.11
Caloric value of coal, lb. water per lb. dry coal, from and at 212 deg. Fah., lb	12.00	11.85
Thermal efficiency of boiler = $\frac{\text{actual evaporation}}{\text{caloric value}}$, per cent	54	77
Chimney and gases.		
Mean position of damper	Full open	Full open
Temperature of furnace gases at end of boiler tube, Fah	above 750°	above 750°
Temperature of furnace gases at base of chimney, Fah	438°	413°
Draft of chimney in side flue at front of boiler, inches of water	0.11 in.	Water gage oscillated from a slight pressure to a vacuum.
Draught of chimney at base of chimney, inches of water	0.61 in.	
Mean analysis of furnace gases, taken every quarter hour: CO_2 p. c. by vol.	8.73	15.35
O " "	8.13	3.14
CO " "	0.88	0.0
Temperature of air in boiler house, Fah	54°	58°
Smoke.		
Total number of times smoke observed	70	7
Total duration of smoke, minutes	105	6
Mean intensity of smoke (Mr. D. K. Clark's smoke scale), number	7	5

In this experiment the bars were rather too wide apart for the small coal used to get the best results.

A Dynamometer for the Back End of a Tender.

The expense of building and operating a dynamometer car has led to several attempts to design a dynamometer that can be applied to the rear end of a tender or the front end of the first car of the train. In all of these that have come to our attention no graphical record has been attempted, the makers being content to read the pull, speed, etc., from gages. On the Northern Pacific Railroad an endeavor was recently made to provide an inexpensive and reliable dynamometer, and the details of the resulting apparatus are shown in the accompanying engravings. It was designed and patented by Mr. McHenry, one of the receivers of the road.

Fig. 2 shows it applied to a tender and the pipe from the diaphragm carried forward under the tender frame and up to the top of the tank where it is connected to a regular steam or hydraulic gage placed in front of the tool box. A small force pump is connected to the pipe near the gage to supply oil to replace that lost by leakage. Fig. 1 gives the details of construction and most of the principal dimensions. It will be seen that a diaphragm is placed in the back of a drawhead. This diaphragm is made out of No. 22 brass, and is soldered to a plate which closes the back of it. A lug on this plate is tapped for the pipe by which the pressure is transmitted to the gage. This diaphragm is held in the drawhead by a large hexagonal nut which also supports the outer portion of diaphragm against the bursting pressure. A circular plate $5\frac{11}{16}$ inches in diameter is soldered on to the face of the diaphragm, on which bears a yoke with a $1\frac{1}{2}$-inch round bar extending forward from each of its ends. These pass through the flange of the drawhead and are secured to another yoke by means of two nuts on each. This second yoke passes transversely through the drawhead and at its center is provided with a slot and pinhole by which an ordinary link and pin can be coupled to it. The whole arrangement is so simple that it will be readily understood.

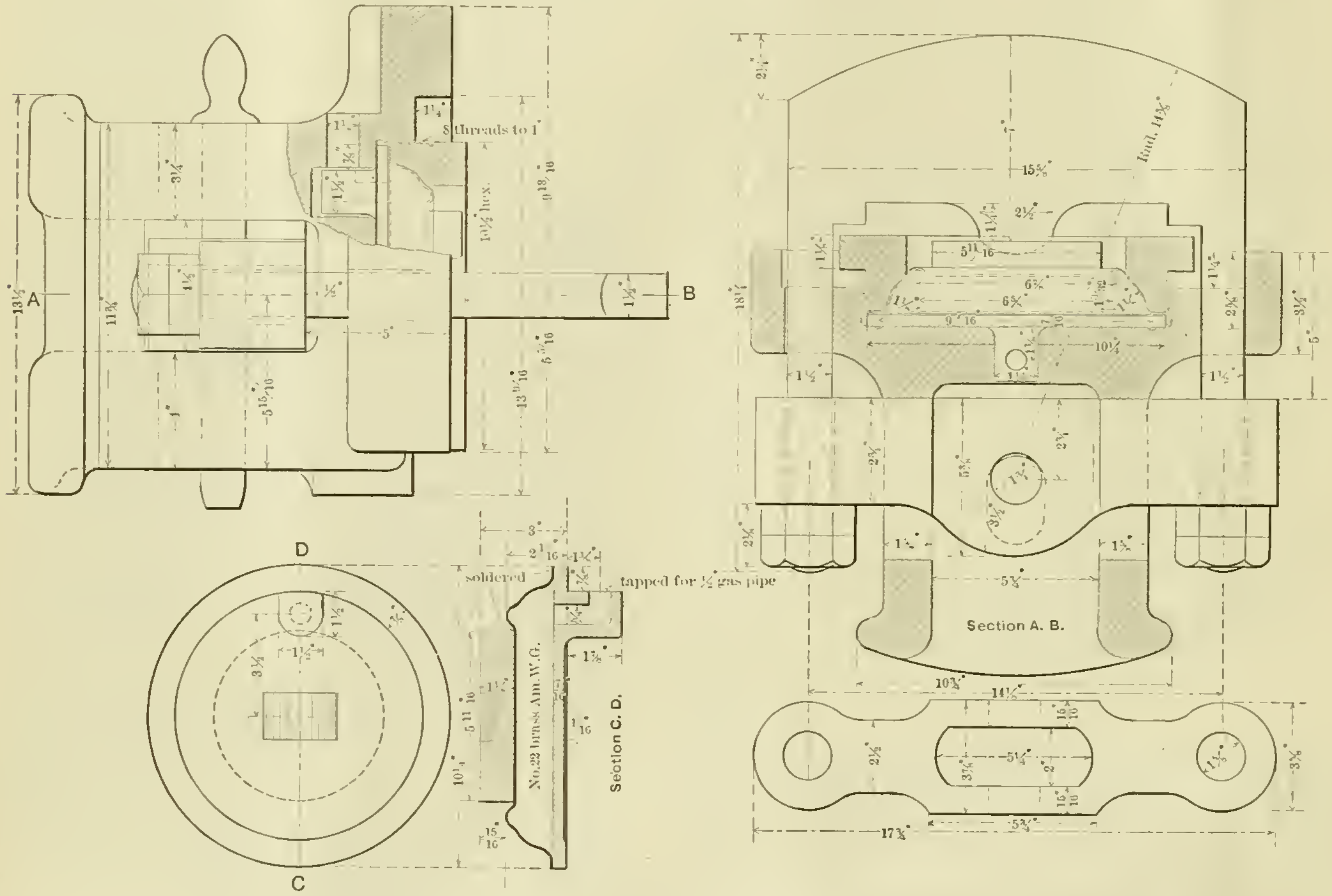


Fig. 1.—Details of McHenry Dynamometer for Back End of Tender.

We have described the dynamometer as applied to a tender, but we learn that though designed for that place it was as a matter of fact attached to a caboose that was run next to the engine. As far as we have been able to learn the only serious trouble experienced in the use of the device was occasioned by the rupture of the diaphragm. This we should think could be overcome by making the unsupported area of the diaphragm considerably less than shown in the drawings. From such investigations as we have been able to make into the requirements for such apparatus we are inclined to think an initial tension on the diaphragm is desirable, but it may not be essential. The apparatus illustrated is certainly one of the most compact that has been constructed for the line of work mentioned.

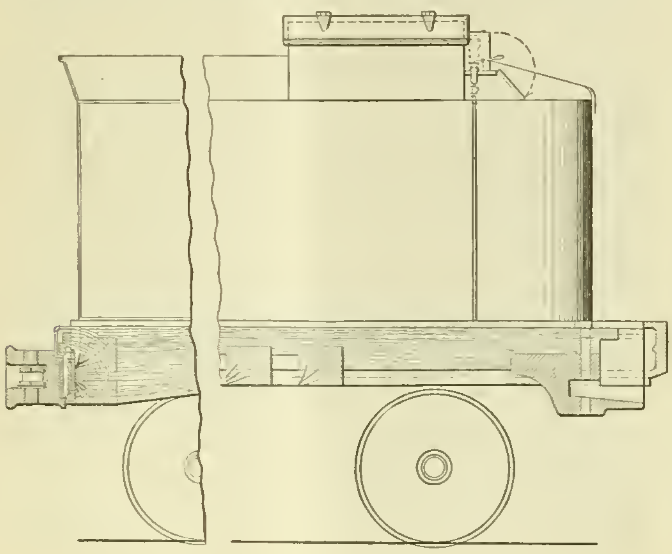


Fig. 2.—Application of Dynamometer to Tender.

Crosby Steam Gage and Valve Company.

This company, as most of our readers know, is a Boston "institution," with its works in Charlestown, of Bunker Hill fame. Recently while enjoying a visit to the Hub the pleasure was increased by an inspection of the works referred to, the expedition being personally conducted by Mr. George H. Eager, the treasurer of the company. The works consist of a main building 451×77 ft. and four stories high, which is thoroughly equipped with the most approved machinery for manufacturing the appliances which are specialties of the company. As its name indicates, the principal products are steam-gages and safety-valves. Of the former they make several different kinds. Among these are the Bourden gage, with an ordinary C-shaped pressure tube, the lower end of which is fixed and the upper connected to the index mechanism. In another form the tube is placed thus, ◌, and held securely in the middle, the two ends being free and attached to a T-shaped lever which operates the index. With these gages a system is used to keep the gage tube filled with water and thus keep it cool. A third form is what they call their "thermostatic water back gage," in which two tubes are placed thus ( ) with their lower ends attached to a chamber which is filled with water or other liquid, and answers the purpose of an ordinary siphon. This chamber is placed between the two tubes. The upper ends of the tubes are connected to a T lever which forms part of the index mechanicism. It is found however, in practice that after the tubes have been tested and adjusted to a certain movement under pressure in the ordinary temperature, and then give correct indication of pressure, that when the tubes are heated in use to a higher temperature they are lengthened thereby to such an extent that their free ends will then move through a larger arc than they did when they were tested, and thus a greater pressure than actually exists in the boiler is indicated on the dial. In the gage which is here described, the long arm of the T lever is made of brass and steel brazed together, which forms a "thermal bar," and the unequal expansion of the two metals compensates for the expansion of the tubes.

These gages, the makers say, are especially adapted for locomotives and for other boilers in which the high pressures now in vogue are used.

The company makes gages for a great variety of purposes, including hydraulic, vacuum water, ammonia, air, gas and pyrometer gages. These are all tested with great care and with apparatus specially constructed for the purpose, with which the testing-room is equipped. The utmost care is exercised, and the greatest precision is aimed at, in testing gages, and any defect is certain to be detected before they leave the company's hands.

Another important branch of the Crosby Company is the manufacture of safety valves. These are of the "pop" type, and are made especially for locomotives. A peculiarity is a flat annular seat, which the company claim can be kept tight easier and longer than any other form. The valves are encased and some types are provided with perforated mufflers to deaden the noise. What is called the Meady valve and the Crosby-Meady valve is made for locomotive and also stationary and marine boilers. A variety of forms and patterns are made adapted to various classes of boilers.

One of the phenomena of modern engineering is the greatly increased use of indicators, as a means of diagnosing the condition and operation of the organs of steam engines. Their use has been greatly extended, no doubt, by the general diffusion of technical education. The result has been that of late years there has been a great demand for reliable indicators, and supplying these has become an important branch of the Crosby Company's business. The introduction of high-speed engines of late years has created a special demand for improved indicators, which the Crosby Company have made great efforts to supply. The greatly increased speed of steam engines has made extreme lightness, a nice adjustment of moving parts and the finest workmanship indispensable in an indicator to make it reliable. To meet these requirements the utmost refinements of good workmanship are essential. The Crosby shops have therefore been equipped with with the very best machinery and appliances to make these instruments of precision, and an elaborate system of manufacturing the parts in duplicate and to gages has been organized, so as to insure the required accuracy. When the instruments are assembled they then go to the testing-room, which is equipped with a very elaborate testing apparatus for subjecting the whole mechanism to a thorough trial before it is pronounced perfect and allowed to leave the hands of the makers.

The construction and the operation of the testing apparatus could not be axplained so as to be understood without illustrations, and for them we have not space, nor is there time to prepare them. It must suffice now to say that every indicator made here is thoroughly tested in every way, so as to make it certain that it is entirely reliable in all respects.

The company also manufacture Amsler's Polar Planimeter, that mechanical puzzle, the action of which few of us old chaps, and probably not many of the younger ones, clearly understand.

Locomotive counters, relief valves, pressure-gage testers, spring-seat globe and angle valves, steam whistles, bell-chime whistles—of which we saw some specimens for Sound steamers with bells 12 × 24 inches—organ whistles for steam launches, etc.; whistle valves, blow-off valves, water-gage glass tubes and columns, water-gage fixtures, etc., etc., are all articles that are made in these works, which are so well equipped in all departments.

Test of a Combine Safety Water Tube Boiler.

A test was recently made of one of these boilers at the Marietta, Pa., Electric Light, Heat and Power Company's station to determine its capacity. It was rated at 125 horse-power, based on an evaporation of 30 pounds of water per hour from a feed water temperature of 100 degrees F. into steam at 70 pounds gage pressure. The test was made by Mr. Jay M. Whitham, Mechanical Engineer of Philadelphia, with the co-operation of Mr. W. Barnet Le Van as the representative of the light, heat and power company. The total heating surface of boiler was 1,100 square feet, the grate area 21,875 square feet. The test was continued for 8 hours and 39 minutes with the following results:

Water evaporated from and at 212 degrees F. per pound of dry coal	9.346 pounds.
Water evaporated from and at 212 degrees F. per pound of combustible	10.52 pounds.
Average boiler horse-power actually developed, by basis of 30 pounds per hour from 100 degrees F. at 70 pounds pressure	161.4
Rated boiler horse-power	125
Horse-power developed above rating	29.1 per cent.
Pounds of dry coal burned per hour per boiler horse-power developed	3.69
Pounds of wet coal burned per hour per boiler horse-power developed	3.76

A Locomotive-Building Plant for Russia.

A firm of American capitalists, to be known as the Russian-American Manufacturing Company, has been incorporated, with headquarters at present in Philadelphia, for the purpose of establishing extensive locomotive works at Nijni-Novgorod, Russia. The firm of Edmund Smith & Company, of Philadelphia, are interested in the project and Mr. W. F. Dixon, formerly of the Rogers Locomotive Works, has visited Russia to look over the site and prepare plans for the shops. The plant is to have a capacity of 200 locomotives per year and contracts for $500,000 of machinery have already been placed with American tool builders. Among those who have received large orders are Bement, Miles & Company, Wm. Sellers & Company, Newton Machine Tool Works and Pedrick & Ayer Company, all of Philadelphia; Hilles & Jones and Betts Machine Company, Wilmington, Del.; the Niles Tool Works, Hamilton, O.; the Morgan Engineering Company, Alliance, O., and Greenlee Bros., Chicago.

The plant is to be built in connection with the Sermova Works, an extensive establishment in Nijni-Novgorod, manufacturing cars, steamboats, steam boilers, etc., and employing 5,000 men. Mr. Dixon will have entire charge of the locomotive works, which will be controlled jointly by the Russian and American companies. The locomotive plant will employ 1,000 men. It is understood that the Czar has encouraged the enterprise.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE,

MORSE BUILDING......................................NEW YORK.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

JULY, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

The great amount of space required to properly report the proceedings of the conventions held in June has excluded from our pages this month much valuable material, among other articles laid over being the second one of the series on the Altoona shops of the Pennsylvania Railroad. This will appear next month.

The topical discussions introduced at the convention of the Master Car Builders' Convention last month were a great success. By having each subject introduced by members who had prepared brief and concise arguments or statements, the discussions were immediately directed upon the essentials of the topic, with the result that the 10 minutes allotted to each subject was usually sufficient to bring out all valuable information in the possession of the members. Preparation of that kind is the secret of topical discussion, and it is probable that the lack of that preparation has had its effect in almost wholly banishing topical discussions from the meetings of the Master Mechanics. The great number of reports presented and the time required for their consideration have also had their effect in eliminating these discussions from the latter body.

The new interchange has won and has received the unanimous approval of the Master Car Builders. No voting by cars was required this year; on the contrary, there was not only an overwhelming sentiment in favor of the new interchange, but an evident desire on the part of the convention to take the entire new code as it came from the Arbitration Committee without discussion or change. Such faith in the committee and its work is justifiable, and we are inclined to think that a similar treatment of its reports each year would not only save much time for the convention, but would result in a better and more consistant code. The changes made on the floor of the convention are apt to be found contradictory or inconsistent with other paragraphs from the simple fact that one cannot at such times keep in mind all the various sections of the code.

By the decision of Judge Coxe, of the Circuit Court of the Northern District of New York, in the suit of the Gould Coupler Company against Pratt & Letchworth, rendered last November, it was decided that any knuckle-opening device that both automatically opened a knuckle and held it open was an infringement on the Browning patent owned by the Gould Coupler Company. If a device performs either one of these functions and not both it is not an infringement. A decision on an appeal from a preliminary injunction by Judge Lacombe, of the United States Circuit Court of Appeals, rendered May 27, defines the limitations of the term automatic, and decides that a device which does not act independently of the will of the operator and without his aid when the lock is raised, but on the other hand requires a distinct and separate movement on the part of the operator to swing the knuckle open, is not automatic, and is not covered by that term in the claim of the Browning patent. The case appears to be far from being settled, however, as the Gould Coupler Company announce that they will proceed with the case as though no injunction had been asked for.

In a discusssion on the pooling of engines at the April meeting of the Western Railway Club, an apparent diversity of opinion existed. We say apparent, for on close reading it seems that members had different definitions of pooling in mind during the discussion. If pooling be taken to mean that method of running engines in which no crew or sets of crews are assigned to any one engine, and no crew is responsible for an engine, then it may be said that there were few friends of pooling present. At the same time it is realized that the highest standards of operation require that engines shall make a large monthly mileage—much larger than can ordinarily be obtained by assigning a single crew to each engine. Hence the practice of assigning two crews to one engine, three to two, five to three, or in a similar way grouping engines and men into what has been called "small pools," instead of one general pool, is gaining in favor, and, we think, rightly so. Pooling, in the broad sense of that term, has generally been found to lead to increased cost of repairs and of fuel, due partly to the lack of interest on the part of the men in the engines they run, and partly through the lack of that familiarity with an engine and its peculiarities which is obtained by long association with it. By so assigning the crews to engines that the motive power will be kept in motion as much of the time as is compatible with proper care and maintenance, and each engine has at least one crew that is responsible for its condition, the large mileage can usually be obtained without the disadvantages associated with a general pool. But lengths of divisions, character of traffic and other local conditions must be taken into account in the decision of any individual case.

Those who believe that the formation of dense smoke in steam plants can be abated and the smoke nuisance in our cities and towns greatly reduced, and who at the same time believe that the formation of smoke cannot be wholly prevented without a loss in the efficiency of the boilers, will doubtless find support for their views in the results of a peculiar competitive test recently carried out under the auspices of the Sheffield Smoke Abatement Society. Five competing firemen were each allowed to fire a Lancashire boiler for seven consecutive hours and the prize was awarded to fireman who evaporated the greatest quantity of water with the least amount of fuel and with the least quantity of smoke. The boiler was 28 feet long and 8 feet in diameter, the two flues being 3 feet 3 inches in diameter at the front, tapering down to 2 feet 10 inches at the back. The grates measured 6 feet by 3 feet 3 inches, giving a total grate area of 39 square feet. The grate bars had ½-inch spaces. The working pressure was 100 pounds per square inch. The coal used was "washed hard nut" and was of uniform size and very clean. The best result as to evaporation was equivalent to 9.03 pounds of water from and at 212 degrees Fahr. per pound of coal, but the fireman with this record had, on the other hand, the worst showing as to smoke. The first prize went to a fireman who secured an equivalent evaporation of 7.95 pounds of steam from and at 212 degrees Fahr., while only producing dense smoke for six minutes out of the whole seven hours occupied by the trial. This record was beaten by two other competitors, one of whom produced dense smoke for two minutes only and was reponsible for an equivalent evaporation of 8.07 pounds per pound of coal, but he produced much more "faint" and medium smoke than the first prize winner, and so failed to head the list. The coal burnt per square foot of grate surface per hour ranged from 23 pounds to 28.1 pounds. Thus we see that the man who produced the least smoke was beaten by three out of four of his competitors on evaporation. While this may go to show that an entire absence of smoke from the average boiler may mean a loss in efficiency, it must be borne in mind that all of the men produced amounts of smoke infinitesimal in comparison with the average fireman of to-day, and that the production of more than formed in the worst of the five trials would have doubtless been accompanied by a falling off in the evaporation. No argument can therefore be drawn against the improvement in the average of present practice so urgently needed.

The problem of providing competent and skillful workmen in the various departments of manufacturing establishments and railroad shops is one that is not easily solved. It is believed, however, that the committee which reported on the subject to the Master Mechanics' Association last month went wide of the mark. We do not intend to take up the matter at any length, at this time, but we would submit for consideration the opinion that the most important part of the problem lies not so much in the opportunity to be given the technical graduate, or the technical education of the apprentice, important as these are, but rather in the shop training of those who by their talents or inclinations are destined to remain in the shop either as workmen or foremen. The technical graduate will generally find means to get as much shop training as he needs, and as he usually has ambitions and a well-defined purpose, his case is a special one capable of special treatment. The well-educated apprentice who is bound to make his trade a stepping-stone to something higher is undoubtedly deserving of encouragement and any help and counsel given him in the shop or out of it will prove a good investment for the individual or firm that tenders it. Nevertheless, the great class demanding consideration on the part of employers we believe to be the average apprentice who intends to remain in the shop and who will end his apprenticeship according to the treatment he receives, either as a skillful and intelligent workman, loyal, independent and manly, and of great value to his employers, or as a mechanic capable of doing few things well, perceiving more or less clearly the injustice of the treatment accorded him, and ready to join the ranks of those who wage the war between capital and labor. The improvement in the training of this class of apprentices, if their presence in the shops is to be continued, must begin with the shop training itself, before it takes up their technical education. It is their right. They go into the shop to work for a certain number of years for a compensation which is to be paid partly in cash but mostly in knowledge. If the opportunity of acquiring the latter has been denied them, they have not been fully paid. even if the cash part of the pay has been forthcoming regularly. And if the employer who keeps a boy on a bolt-cutter or a drill-press or doing the lower grades of work about a shop, until most of his time has been spent, considers he is just in his treatment of the boy, or has put money in his own pocket, he is mistaken. He has not only been unfair to the apprentice, but he has actually failed to benefit by his services as much as he might. This class of apprentices who learn a trade and work at it for life, are the most numerous class, and employers are interested in improving their facilities and opportunities for acquiring knowledge.

REDUCED LEAD FOR LOCOMOTIVES.

The mechanical officials of a number of large railroads in the West have recently given much attention to the effect of various amounts of lead upon the steam distribution and economical performance of locomotives. The time-honored rule in valve-setting in many parts of the country has been to give the engine $\frac{1}{32}$ or $\frac{1}{16}$ lead in full gear, and trust to luck for good results in the working cut-off. With some valve gears this method of setting gives a lead of about one-quarter inch in the six-inch cut-off, while with others it may give as much as three-eighths of an inch. The latter condition is almost certain to produce a bad riding engine—one that is uncomfortable for the men and hard on its machinery, besides being less efficient.

The few who have had the hardihood to disregard that aged and much respected rule by which a given amount of lead is carefully provided at full stroke where it is of no account, and allowed to be settled by mere chance at cut-offs where it plays an important part in the working of the engine, have adopted various methods of obtaining a desirable lead at the cut-offs where the engine does most of its work. One of these methods is to set the valves blind in full gear by an amount sufficient to give the proper lead at the working cut-off. This sometimes results in the valves being nearly one-quarter inch blind in full gear to get, say, three-sixteenths lead at six inch cut-off. Contrary to what some persons would expect, a passenger engine with the valves so set will work admirably. Another method for accomplishing the same result is to set the valves about line and line in full gear forward and to move the backing-up eccentrics until the lead at the working cut-off is reduced to the desired figure. This method is all right for a passenger engine, but may not be desirable on a freight engine that is called upon to back heavy trains. Evidently a combination of the two methods mentioned might also be employed. Each of the methods has had its advocates, but the experience of the roads referred to teaches two lessons most clearly: First, that the lead on fast passenger engines, whose valves are set with lead in full gear for forward and backward motion, is too great in early cut-offs; and, second, that it makes comparatively little difference in the working of a road engine how the reduction of lead is effected, providing, of course, that the valves are not set in a manner that will place the engine at a disadvantage in occasional switching operations or other special duties. The essential condition seems to be that the lead should be just sufficient to admit the right amount of steam to obtain boiler pressure in the cylinder at the end of the stroke under the average conditions of speed and cut-off. To provide more lead than this is to produce a loop on the diagram, an undue strain on the running gear, greater friction in the engine when passing the dead centers, a poorer steam admission line with its consequent loss of power, and a bad riding engine. Having determined the right amount of lead to overcome these troubles, experience shows that there is but little choice between the methods of obtaining it, as the advantages which any one method may appear to have in delaying the exhaust opening or closure, or affecting other points in the steam distribution, are small compared with the gain from proper lead.

The gain in power from the reduction of the lead is remarkable. It has been found to make passenger engines smart and capable of making up time with trains that under the old method of setting they could hardly haul on schedule time, and has enabled freight engines to handle satisfactorily ten per cent. heavier trains. It is needless to add that where Allen valves are used the lead should be cut down to an amount sufficient to produce exactly the same influx of steam at the end of the stroke as with the plain valve. This done, the greatest advantage of the Allen valve will be realized. This seems to be the gist of the matter and the conclusions certainly appeal to the sound sense of those who are familiar with the problems associated with the proper distribution of steam in locomotives.

COUNTERBALANCING LOCOMOTIVES.

The report on counterbalancing locomotives presented to the Master Mechanics' Association last month is the best contribution to the subject that has appeared for a long time. It is brief and to the point, and the committee in recommending that the weight of reciprocating parts left unbalanced should bear a definite ratio to the total weight of the engine rather than to the weight of the reciprocating parts themselves, undoubtedly formulated the only correct rule. Experience may show that the ratio should vary somewhat with the length of the engines, the wheel bases and the weight on the forward trucks, but the principle on which the rule is based will stand.

The discussion of the report brought out the vicious character of some of the methods of counterbalancing at present in vogue. The worst of these is that of the unequal distribution among the drivers of the counterbalance for the reciprocating parts Sometimes this is done so that the same wheel pattern can be used in eight-wheeled engines, and in consolidation, mogul or ten-wheeled engines, it is often done because it is impossible to put the proper amount of counterbalance in the main wheels. Now, the old rules of balancing from 60 to 90 or even 100 per cent. of the reciprocating parts and equally distributing that balance among the drivers is not as scientifically correct as the rule proposed by the committee, but we venture the assertion that no case of bent rails or other damage to track ever occurred where such a rule was followed. The damage to track has always resulted from a shortage of counterbalance in one pair of wheels being made up by an excess in others. There is no excuse for such bad practices. In eight-wheeled engines it is always possible to put the correct amount of counterweight in each wheel and the same is true of mogul and ten-wheeled engines whose drivers are large enough for fast service.

In freight engines of these or the consolidation types, it may be impossible to get the required amount in the main wheels, but it is much better practice to let the total amount of counterbalance for the reciprocating parts fall short of the amount required by rule than to make up the shortage by placing excessive weights on the other wheels. It is true that a small amount of the shortage might be thus made up with safety in some cases, but the practice is a dangerous one unless the assignment of the weights to the various wheels is made by one familiar with the whole problem. The rule proposed by the committee will tend to correct this evil, as freight engines of the types mentioned are usually quite heavy, and a larger portion of the reciprocating parts can be left unbalanced, thus making it possible in practice to get nearer to the total counterbalance required in the main wheels. But master mechanics will still meet with special cases, and then the caution to be heeded, if one would prevent damage to track, is to avoid an excess of counterweight in any one pair of wheels.

THE CONVENTIONS.

The Car Builders' and Master Mechanics' annual conventions have now become established "institutions" in this country and those who are connected directly and indirectly with the two departments of railroad operation, which are represented at those meetings, would feel that the year would be as incomplete without them as it would be if Fourth of July and Christmas were omitted. The attendance this year was larger than ever, and it may readily be understood that those who have been coming to these meetings for five, ten, twenty or twenty-five years have made many pleasant acquaintances in that time, and that the annual assemblages have not only their technical and professional interest, but that they are social reunions, around which many pleasant reminiscences cling, and which recall some sad recollections. The people who go there have, of course, changed very much during the period that has intervened since the associations were first organized. Some of us who have been in attendance for a quarter of a century are compelled to admit

"That we, we are the old men now;
Our blood is faint and chill;
We cannot leap the mighty brook,
Or climb the breakneck hill.
We maunder down the shortest cuts;
We rest on stick or stile,
And the young men, half ashamed to laugh,
Yet pass us with a smile."

Some one has said that "young men think old men are fools, but old men know young men to be so." The Germans have a maxim that the "old effect more by counsel than the young by action," and another proverb is to the effect that "experience without learning is better than learning without experience," and Dr. Johnson said that "experience is the great test of truth, and is perpetually contradicting the theories of men." Nevertheless it must be admitted, in the words of an Eastern adage, that "a prudent youth is superior to a stupid old man," and taken all together that the young chaps have the best of us.

These reflections are suggested somewhat by the character of the proceedings of the meetings. A comparison of the reports presented in Saratoga with those made, say, 10 or 20 years ago, will indicate that a new element has been introduced into the association. That element is the graduate of the technical school. He has now assumed control and is likely to keep it. It has been said of youth that it is a defect which cures itself, and the same is true of the inexperience with which the graduates of technical schools were charged not long ago. If they are appointed and remain in responsible places, they are certain to get experience, and will thus be obliged to submit themselves to the contradictory teaching which Dr. Johnson referred to. In view of this, the old chaps can temporarily tolerate such crudities as may sometimes float on the surface, knowing full well, that the authors of them will in time learn, what some of us have found out by hard knocks, which is that those things which are not quite sure are very uncertain.

There are two considerations which should never be lost sight of by committees in preparing reports for these associations. One of these is that the majority of the members are and probably always will be men whose schooling has been in the shop, and who are erudite in experience, but not in scientific knowledge, and who are more skillful in the use of mechanics' tools than in mathematical formulæ. As this class forms the majority of the the members they should not be ignored, as they are when reports contain much matter which is incomprehensible to the practicians. A report should be adapted to its purpose, and at least part of it should be understandable by those to whom it is read and for whose edification it is intended.

The other part which is often lost sight of by the authors of reports is the limited time and attention which can be given to them. The Car Builders hold two sessions of three hours each for three successive days, and the Master Mechanics one session of five hours, so that at most they are only in session from fifteen to eighteen hours, a considerable portion of which time is devoted to routine business. The Master Mechanics this year had reports on ten different subjects, and the Master Car Builders on twelve. It is, therefore, almost impossible to devote an average of as much as an hour to the reading and discussion of each of the reports.

Then, too, there is the fact so seldom realized that it is extremely difficult to keep the attention of an audience on anything which is read for more than 20 minutes, and to do that it must be interesting and easily comprehended and followed. The task which a committee must therefore assume is the preparation of a report which will not consume more than 20 minutes in the reading of it, and can easily be followed and understood by those who hear it. Just to the extent that the reading exceeds that limit of time, and is difficult of comprehension the work of the committee fails in what should be the purpose of their report. If any highly scientific and abstruse investigation or dissertations are essential to the deductions or the conclusions in the report, these should be relegated to appendices to be printed with it but not read.

The reports this year, it is thought, were quite up to the average in interest and value. Some of them are rather tough reading, as for example the one on "Exhaust Pipes," which embraces two distinct investigations, the reports of which are not as lucid as they might be. The report on "Slide Valves" opened an animated discussion and some of the conclusions of the committee were questioned, and on some points the authors were finally driven to the admission that they were not quite sure of their ground. It is to be regretted that the funds of the association would not permit of more complete illustrations of this report, which, if not entirely sound in some of its deductions, was at least very suggestive.

The metrical system of measurement, or rather its compulsory adoption, was also up for consideration, but the measure met with little favor. The advocates of this movement should read Herbert Spencer's article on it, which was published in the June number of Appleton's Popular Science Monthly.

The declination of Mr. Sinclair of the office of Secretary of the Master Mechanics' Association left a vacancy which was filled by he appointment of Mr. Cloud to that office, who thus becomes Secretary of both associations. This, it is hoped by some, may lead to their consolidation.

The time which must now be given by any one who wishes to attend both meetings is greater than most of them who come to them can afford. The sessions at Saratoga began on Tuesday morning and ended at noon on Wednesday of the following week, and changes made in the by-laws will add two days to this period for next year. The Master Mechanics met on Monday morning of the second week. If they should hold their meetings on Monday, Tuesday and Wednesday there seems to be no reason why the Car Builders could not hold theirs on Thursday, Friday and Saturday following, which would compress the whole session into one week, which seems very desirable.

The general verdict of all was that there was no place like Saratoga for these meetings. The hotels give unlimited accommodation to those who attend, and there need be no dissatisfaction on that account. The balmy atmosphere and the aperitive waters seem to incline the sojourners to deliberation, and open their minds to the reception of knowledge and new ideas.

Colonel Clement, the proprietor of Congress Hall, was again entitled to the thanks of his guests, who were entertained by him with the same hospitality that he has dispensed on previous occasions, and many left his hostelry feeling that their thanks were still due to the host after their bills were paid.

NOTES.

The Pullman car service on the Omaha line of the Northwestern Railroad has been displaced by the Wagner car service, through a contract signed about six weeks ago. The Pullman Company is said to have made a hard fight to retain the business; but the Vanderbilt interests in the Northwestern road, which controls the Omaha line, were too powerful to be overcome, and, as a result, the Pullman cars will have to go. This will increase the mileage served by the Wagner Palace Car Company by some 1,500 miles.

Locomotive engineers and firemen in England are urging the adoption of American cabs on English engines. Several meetings of the men have been held at the large railroad centers in order to bring before the companies the adoption of this reform. A committee appointed by the men have examined the cabs on the North Eastern Railway, and an engineer has returned from a visit to this country for the purpose of reporting on our practice, and the resolutions passed at the meetings of the men ask for cabs as good as those on the North Eastern and on the American roads.

The unjust treatment to which many railroads are subjected in the columns of the daily press is aptly illustrated by the case of the Illinois Central. Some of the Chicago dailies cannot refer to the road without employing offensive epithets and no opportunity is lost to influence public opinion against it; and yet this same road pays the state 7 per cent. of its gross earnings on the 705 miles of original road, amounting at present to nearly $700,000 per year. It has altogether paid about fifteen and one-half millions into the state treasury, and twice in the last fiscal year it has come to the aid of the state by paying $300,000 of its taxes in advance. It has spent four or five millions in improvements within the limits of Chicago in the last three or four years, and is now altering the grade of its tracks near the terminals, building sea walls, and co-operating with the city in the improvement of the Lake Front park at an outlay to itself of a million or two, but of course these things should not count in its favor or influence the action of the dailies referred to.

In a series of tests conducted on the Buffalo & Niagara Falls Electric Railway by Messrs. H. O. Pond and H. P. Curtis and published in the *Sibley Journal of Engineering*, the following results were obtained:

Friction of the car on straight level tracks	208.5 pounds
Traction coefficient on straight level tracks	6.86 pounds per 1000
Acceleration horse power, from zero to full speed	16.03 horse power
Average current taken by the car in passing over the entire line	63.4 amp
Average voltage on the line, from several tests	513.1 volts
Average electric horse power of car over the entire line	40.44 horse power
Average drop in potential on Buffalo end of line	5.1 per cent
Average speed over the entire line	23 miles per hour
Maximum speed, on a regular run	36 miles per hour
Maximum speed attained	42 miles per hour
Maximum current taken by car during tests	188 amp
Maximum voltage at car during tests	583 volts
Maximum electric horse power of car during tests	143 horse power

During these tests the cars never carried a full load, but generally ran light. The track and overhead construction are of the best. The road has only two grades in its entire length of 22 miles. The cars are 28 feet long over the body, 36 feet over all and weigh 22,000 pounds, with the motors and without passengers. They are carried on the Brill Company's privotal trucks, each truck having two G. E. 800 motors.

With a view of increasing railway construction in India, the Government has announced that on proposed branch and feeder lines approved by it, it will give a guarantee of interest of 3 per cent. per annum on the authorized capital, while in some cases it may be arranged as an alternative that a payment be made to the branch company sufficient to bring up the earnings of the latter to 3½ per cent. on the authorized capital, provided always that the main line company is not called upon to pay more than it has earned from the new traffic. In order to take advantage of these concessions, the branch lines in question must not exceed 100 miles in length. A prior right to construct such feeders will be given to the administrations of the trunk lines, but if they do not undertake it the matter may be taken in hand by other parties. The plans and estimates must be approved by the Government, and any further capital expenditure after completion must also be sanctioned by the same authorities. The Government agrees to provide the land required free of cost, inclusive of quarries, ballast pits, brick fields, etc., and to provide and maintain the telegraph service at the usual charges for such work. Materials for construction will be carried over the State lines at special rates. The

Government reserves the right to purchase such lines at the end of 21 years, at a cost of not more than 20 per cent. above the capital cost of the line nor less than the par value of the same.

According to an article by Mr. Charles E. Barry, in the *Sibley Journal of Engineering*, there is but one producer gas engine plant in commercial operation in this country, and that was built in 1892 by the Danbury & Bethel Car and Electric Company, of Danbury, Conn., for the purpose of supplying electric light to the towns of Danbury and Bethel. The station equipment consists of three 100-horse-power horizontal engines, built by the Otto Gas Engine Works, of Philadelphia, belted to a jack shaft carrying a three-ton flywheel, and from which one 750 and one 1,500-light Westinghouse 1,000-volt alternator, two commercial and three street arc machines are driven. The gas engines are of the twin-cylinder type, having two horizontal cylinders placed one above the other, and working on the one crank. The cylinders are 14⅜ inches in diameter and 25 inches stroke. In a test these engines produced a horse-power-hour for each 1.129 pounds of coal used in the producer, equivalent to .979 pounds of combustible per hour. The gas per one horse power per hour was 76.3 cubic feet. The engines ran at 164 revolutions per minute. Of the total heat supplied to the engine 39.09 per cent. was absorbed by the jacket water, 25.61 per cent. passed out in the exhaust, 13.66 per cent. was lost through radiation, etc., and 21.64 per cent. converted into useful work. The mechanical efficiency of the engines was 85.39 per cent., and the dynamos 81.53 per cent. The efficiency of the producers was 84 per cent. The jack shaft consumed 35 horse power.

Personals.

W. W. Finley has been chosen Vice-President and Manager of the Great Northern.

Mr. H. H. Rogers, of New York, has been chosen President of the Ohio River Railroad.

Mr. J. E. Cannon has been promoted to the position of Master Mechanic of the Great Northern at Barnesville, Minn.

Mr. Frank T. Hyndman has been appointed Master Mechanic of the Pittsburgh & Western, vice J. N. Kobaugh, resigned.

Mr. Frank Singer has been appointed Master Mechanic of the Midland Terminal Railway, with headquarters at Gillett, Col.

Mr. W. V. McCracken has retired from the Presidency of the Louisville, St. Louis & Texas owing to the reorganization of that property.

Mr. S. W. Fordyce has been made Receiver of the Stuttgart & Arkansas River Railroad, and Mr. H. E. Martin is Manager for the Receiver.

Mr. J. M. Schoonmaker, of Pittsburgh, Pa., has been chosen Vice-President of the Pittsburgh & Lake Erie, to succeed Mr. James H. Reed, resigned.

Mr. R. F. Hoke, President of the Georgia, Carolina & Northern, has been chosen President of the North Carolina Car Company in place of Mr. Julius Lewis.

Mr. H. N. Woodward has been appointed Master Mechanic of the Baltimore & Ohio shops at Parkersburg, to succeed Mr. J. H. Irvin, assigned to other duties.

Mr. D. L. Anderson has been appointed Secretary and Purchasing Agent of the Louisville, Evansville & St. Louis, with headquarters at Evansville, Ind.

W. S. Calhoun, who has been the railroad representative of the Brussels Tapestry Company, of Chauncey, N. Y., has been appointed General Manager of the Company.

Mr. Attilla Cox, receiver of the Louisvile St. Louis & Texas, has been chosen President of the reorganized company, which will be known as the Louisville, Henderson & St. Louis.

Mr. George S. Edgell has been elected Second Vice-President of the Long Island Railroad. He is a son-in-law of the late Austin Corbin, formerly President of the Long Island Railroad.

Mr. Wm. P. Palmer has been elected Second Vice-President of the Illinois Steel Company, vice Mr. Robert Forsyth, resigned. He will look after the commercial interests of the company.

Mr. C. H. Warren has resigned as General Manager of the Montana Central, which has heretofore been operated by the Great Northern, and it will hereafter have its own corps of officials.

Mr. William J. Fransioli has been appointed Acting General Manager of the Manhattan Railway, of New York City, to succeed F. K. Hain, deceased. He was formerly chief clerk to General Manager Hain.

Mr. W. R. Stirling has resigned the Vice-Presidency of the Illinois Steel Company to devote his entire time to the Universal Construction Company, which recenty leased the north works of the Illinois Steel Company.

Mr. O. O. Winter, Division Superintendent of the Great Northern at Minneapolis, Minn., has resigned to accept the position of General Manager of the Brainerd & Northern Minnesota, with headquarters at Brainerd, Minn.

Mr. W. E. Looney has retired from the position of Master Car Builder of the Louisville, Evansville & St. Louis, and the office has been abolished. The master mechanic will hereafter have charge of the car department.

It is announced that Mr. Archie McLean has been appointed Superintendent of Motive Power and Equipment of the Georgia Northern road, vice Mr. Albert Marugg, resigned. Mr. McLean's headquarters will be at Pidcock, Ga.

Mr. Parley I. Perrin, for many years Superintendent of the Taunton Locomotive Works, died at Taunton last month, in the eighty-fourth year of his age. He joined the Taunton Locomotive Works as draftsman and foreman in 1846.

Mr. C. B. McCall, General Freight and Passenger Agent of the Chicago, Paducah & Memphis, has been appointed General Manager of the Litchfield, Carrollton & Western, with headquarters at Carlinville, Ill., in place of Mr. T. D. Hinchcliffe, resigned.

Mr. C. P. Clark has been appointed Assistant General Manager of the New England Railroad, with office at No. 180 Summer street, Boston. The duties of the Assistant General Manager will be the same as those assigned by the Board to the General Manager.

Mr. J. J. Turner, Vice-President and General Manager of the Vandalia Line, will remove his headquarters from Terre Haute, Ind., to St. Louis, Mo., July 1. Mr. Charles R. Peddle, Purchasing Agent of the road, will also remove his headquarters to St. Louis at the same time.

Mr. St. John Boyle has been made sole Receiver of the Chesapeake, Ohio & Southwestern, owing to the death of Gen. John Echols, who was associate Receiver and General Manager. Mr. Boyle will also act as General Manager until the road is turned over to the Illinois Central.

Mr. E. L. Weisgerber has been appointed Master Mechanic of the Mt. Clare shops of the Baltimore & Ohio Railroad. He was formerly Master Mechanic of the shops at Newark, O. Mr. William Harrison, Jr. has been appointed Master Mechanic of the shops at Newark, O., to succeed Mr. Weisgerber.

Mr. E. S. Marshall, formerly Master Mechanic of the St. Louis & Southwestern Railroad, is now Assistant Manager of the Railway Equipment Company, of St. Louis, which manufactures and sells the Houston track-sanding device, the economical slack adjuster and several other railroad devices. Mr. Marshall is also Manager of the Railroad Department of the Missouri Malleable Iron Company, of East St. Louis, Ill.

Mr. D. B. Robinson has accepted the Presidency of the St. Louis & San Francisco, which is undergoing reorganization, and has tendered his resignation as First Vice-President of the Atchison, Topeka & Santa Fe, to take effect July 1. Mr. Robinson has been in railway service since 1866, and has been First Vice-President of the A., T. & S. F. since March 7, 1893. His headquarters as President of the St. Louis & San Francisco will be at St. Louis, Mo.

Arthur B. Underhill, for many years Superintendent of Motive Power of the Boston & Albany, died at Springfield, Mass., May 24. He was born at Chester, N. H., October 23, 1832, and entered railway service in 1860 as Foreman Repair Shops, Boston & Worcester. From 1864 to 1880 was Master Mechanic of the Boston & Worcester. He was appointed Superintendent of Motive Power of Boston & Albany, September 1, 1880, which position he held until December, 1893, when he resigned on account of ill health.

On June 18th the degree of Doctor of Engineering was conferred by the faculty and trustees of Stevens Institute upon Commodore George W. Melville, Engineer-in-Chief of the United States Navy, in appreciation of the excellent engineering work performed by Commodore Melville for his country and the advancement of the science of steam engineering, so well illustrated in the world-wide famed "white squadron." Only once before in the 25 years' history of the Stevens Institute has the degree of Doctor of Engineering been conferred, and then upon Prof. R. H. Thurston, of Rhode Island, who formerly occupied the chair of Mechanical Engineering in Stevens Institute and is now Director of Sibley College, Cornell University.

Mr. Edwin M. Winter, General Manager of the Chicago, St. Paul, Minneapolis & Omaha, has been selected by the Northern Pacific Reorganization Committee to be President of the company. Mr. Winter has been with the Chicago, St. Paul, Minneapolis & Omaha since 1876. He was born in Vermont in 1845, and entered railroad service in 1867. His first work was in the construction department of the Union Pacific, where he remained for about three years. Subsequently he was a contractor's agent for construction work on various railroads, General Claim Agent for the Chicago & Northwestern, General Superintendent of the West Wisconsin, and has held his present position of General Manager since 1885.

Mr. Austin Corbin, President of the Long Island Railroad, was fatally injured by a runaway team at his summer residence at Newport, N. H., on June 4. Mr. Corbin was born at Newport, N. H., July 11, 1827, and graduated from the Harvard Law School in 1849. In 1851 he removed to Davenport, Ia., where he lived for 14 years. He located in New York in 1865 and established the banking house of Austin Corbin & Company. Soon thereafter he secured control of the Long Island Railroad, which he extended from year to year, until it has become a great system, reaching almost every portion of Long Island. He was at different times interested in many other railway enterprises, being President of the Indiana, Bloomington & Western; President of the Philadelphia & Reading road from September, 1866, to June 27, 1890; President of the Elmira, Cortland & Northern, and in 1892 was for a few months President of the New York & New England.

Gen. John B. Gray, Vice-President of the American Brake Company, whose home for several years has been in Brooklyn, N. Y., died of Brights disease at Asheville, N. C., on June 6, 1896, after a lingering illness. General Gray was born at Sheridan, June 25, 1831. The beginning of his business career was in New York City, but, on becoming of age, he removed to St. Louis Mo., where he was engaged in mercantile business for some ten years prior to the war. He had an honorable career during the war, and at its close was offered at different times several important positions in the service of the government. These he declined. In 1880 he became connected with the American Brake Company, of St. Louis, of which he was President for several years. In 1888 he was instrumental in effecting a lease of the American Brake Company to the Westinghouse Air Brake Company, and has, since that time, had general charge of the eastern business of the driver brake department of the Westinghouse Air Brake Company. During the past two years his health has been continually declining. Last summer he went abroad for several months, and shortly after his return he went to Asheville, N. C., where, the climate seeming to benefit him, he commenced building a home, which was not yet quite completed at the time of his death.

Equipment Notes.

The Erie Railroad is in the market for 20 locomotives.

The Chicago, Paducah & Memphis road is negotiating for 500 to 1,000 cars.

The Cleveland, Lorain & Wheeling has placed an order with the Peninsular Car Works for 300 30-ton flat cars.

The Barney & Smith Car Company is building three closed and fourteen open cars for the Mount Clements electric road.

The Georgia & Alabama Railroad has ordered eight passenger coaches from the Ohio Falls Car Manufacturing Company.

About 100 refrigerator cars are being fitted up at the Philadelphia, Wilmington & Baltimore shops at Wilmington, for the shipment of fruit.

The Michigan-Peninsular Car Company, Detroit, Mich., has received an order from the Lehigh Valley Railroad Company for 50 double-deck stock cars.

The Ensign Manufacturing Co., of Huntington, W. Va., has been awarded the contract for 100 thirty-ton hopper gondola cars for the Chesapeake & Ohio.

The Ohio Falls Car Manufacturing Company has received an order from the Baltimore & Ohio Southwestern Railroad Company to repair 600 freight cars.

The Chicago, Burlington & Quincy has placed orders for 1,000 stock cars; 750 to go to the Michigan Peninsular Car Company and 250 to the Wells & French Company.

The Florida & East Coast Railroad has placed an order with the Elliott Car Works for 100 freight cars. This road is in the market for additional equipment.

At the shops of the Pennsylvania, at Fort Wayne, there have recently been completed 175 gondola cars, and work has been now commenced on the building of 25 cars for dairy product and 10 large furniture cars.

The Wagner Palace Car Company's shops have turned out two compartment cars for service on the Chicago & Northwestern road, which are considered superior in beauty of finish to anything ever turned out of the shops.

The Billmeyer & Small Car Company, York, Pa., has under construction four cars for Bolivia, South America, where they will be used for excursion purposes. They are also building four for Venezuela, adapted for carrying sugar cane.

The Brooklyn Heights electric road, Brooklyn, N. Y., has recently added to its equipment a third theater car, built by the J. G. Brill Company, Philadelphia, Pa. The length over end panels is 24 feet; width at sill, 7 feet and width at Belt rail, 7 feet.

The Texas Midland Railroad has placed an order with the St. Charles Car Company for $125,000 worth of rolling stock. The order includes seven new coaches, five baggage cars, fifty furniture cars, ten tank cars, five cabooses and a private car.

The Imperial Railways of North China will receive proposals for building four passenger and four freight locomotives for use on the extension of the road from Tien Tsin to Lu-Kon-Chiao.

The bids will be opened at the company's office at Tien Tsin, August 25.

It is announced that the Northern Pacific is about to change four of its standard mogul 18 by 24 engines into compounds. They will all be different types—Richmond, Schenectady, Brooks and Pittsburgh. The intention is to put them into service, running against simple engines.

Four new sleeping-cars have just been sent from the Wagner Palace Car shops, at East Buffalo, to St. Paul, Minn., for use on the Chicago, St. Paul, Minneapolis & Omaha. These are the first Wagner cars used on the road, this company having recently taken the business away from the Pullman Company.

The Illinois Central has awarded a contract for 500 coal cars to the Wells-French Company, and 300 refrigerator cars to the United States Rolling Company. These last named cars will be built at the Hegewich plant of the company. It is rumored that the road will soon place another and large order for cars.

The contracts for some of the 75 Baltimore & Ohio engines were let shortly after our June issue went to press. Other contracts followed and the orders are now distributed as follows: Richmond Locomotive Works, 25; Baldwin Locomotive Works, 20; Pittsburg Locomotive Works, 20, and Cook Locomotive Works, 10.

At a recent test of the Baldwin-Westinghouse Electric Locomotive at the shops of the Westinghouse Air Brake Company, at Wilmerding, Pa., a speed of 45 miles an hour was developed, the engine hauling 25 freight cars. In the near future a public test of the engine will be made, to which a large number of railroad men will be invited.

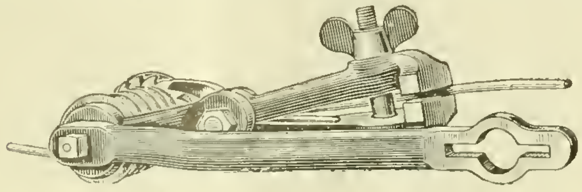
Eight new coaches and six new Wagner Sleeping cars have been put into the daily through service between New York and Montreal, via the Adirondack & St. Lawrence division of the New York Central. The day coaches have accommodations for first and second-class passengers. New mail and express cars will also be assigned to these trains.

As illustrating the heavy expense which railroads are compelled to incur in equipping the cars with automatic brakes and couplers, it may be cited that the receivers of the Baltimore & Ohio have asked and obtained authority from the court to borrow $409,851 in addition to money already spent for the equipment of the rolling stock with brakes and couplers in conformity to law.

It has been stated in several papers that the Richmond Locomotive Works has received an order from the Chicago, Cleveland, Cincinnati & St. Louis Railway to convert 60 locomotives into compounds. This is not true. They are to convert a few engines only at present, and if they are satisfactory others may be changed from time to time, as they require heavy repairs on the cylinders and attached parts.

The Doherty Patent Combined Vise and Winch.

Brown, Jaeger & Company, No. 919 Betz Building, Philadelphia, Pa., are the sole manufacturers of the Doherty combined vise and winch, which is shown in the accompanying cut. The manner of using it is apparent at a glance. This tool will evidently in a short time replace the old-time "strap and vise" or "block and fall" used at present in telegraph, telephone, trolley wiring, electric light line work, in tightening guy wires, in putting up suspension wires for ærial cables, pulling up wires and in cutting out slack. In fact it



can be used for stringing wires of every description upon poles or fixtures of any kind and in tightening all gages of wire to any advisable degree of tension.

It is available for use in making repairs to "live wires" without the necessity of employing the usual "cut outs" thus preserving the linemen from the danger of the "cut out" falling off. The tool itself being entirely of metallic construction completes the circuit. On electrical test it has been shown, that the Doherty combined vise and winch shows no resistance. The usefulness and worth of the implement is summed up in the following statement; One man can pull up two miles of wire at one time with greater ease, more quickly and more effectively, than the usual gang of four men can pull up two ordinary sections with the "strap and vise" or "block and fall" in use at present. As an indication of its power, it is only necessary to state that it can pull apart a No. 8 iron wire in an ordinary section. Its merit lies in saving money, labor, time, and life. The weight of the tool is about six pounds.

The Niagara Spray Ejector for Urinals.

To economize in the use of water and also to overcome the annoyance from clogging, so often experienced in flushing slab urinals by means of perforated pipe, S. J. Putnam, Prince's Bay, N. Y., has brought out the fixture shown in the appended illustrations.

The ejector shown in Fig. 1 may be secured into the front side of

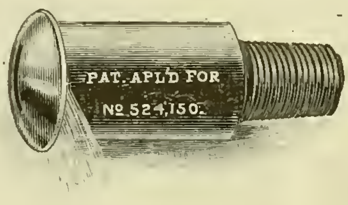


Fig. I.

the supply pipe which passes across the stall. in the place of perforated pipe.

The force of water on the internal spherical head of the screw cap at the slot, throws a fan-shaped spray obliquely against the slab, flushing the entire surface in an efficient manner. As the outlet is

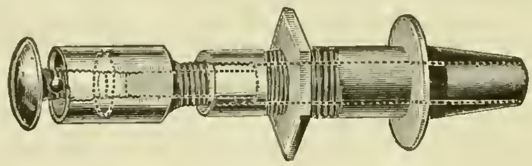


Fig. 2.

equal to only two holes in a perforated pipe, a large saving of water is evident, and owing to its peculiar construction there is but little chance for clogging. If the spray should become clogged by rust or dirt it can be instantly cleared without disturbing the couplings. A minimum of pressure may be obtained by using a stop-cock, which will also add to the amount of water saved. The screw-cap has a lock, therefore no part can get lost or destroyed.

The special coupling shown in Fig. 2, is used for high slab work

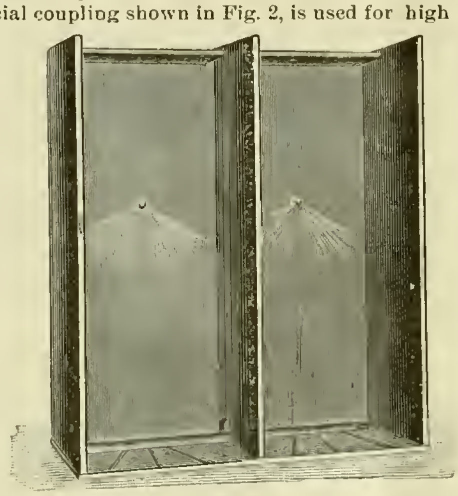


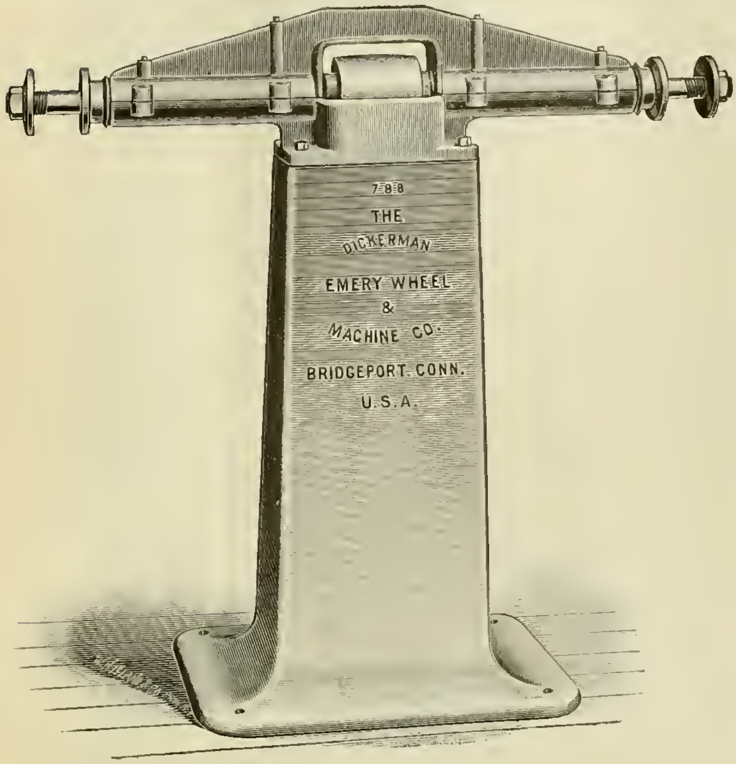
Fig. 3.

where the supply pipes are behind the slab. It passes directly through the slab and is clamped firmly to the same by the nut, which is provided with left-hand thread.

Fig. 3 shows two stalls with fixtures complete and water turned on. Mr. Putnam will cheerfully furnish fuller information to those of our readers writing him

The Dickerman Buffing Lathe.

The buffing lathe illustrated herewith is made by the Dickerman Emery Wheel and Machine Company, Bridgeport, Conn., and is a departure, to a certain extent, from machines of this character. The spindle has a bearing the entire length of each box, precluding any whipping or jumping of the spindle from belt action. It is

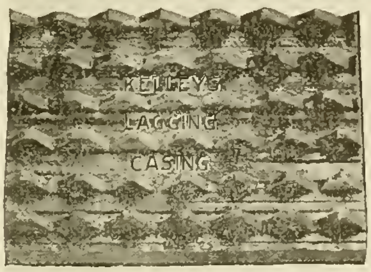


Dickerman Buffing Lathe.

turned from machinery steel and means are provided for taking up end thrust. A maximum amount of room beneath the spindle for buffing large pieces is obtained by having no projections on either the base or the underside of the boxes. The machine is especially adapted for buffing bicycle frames and similar work. The dimensions are: Height, floor to center of spindle, 40 inches; diameter of spindle in bearings, $1\frac{1}{2}$ inches; diameter of spindle at wheel fit, $1\frac{1}{4}$ inches; length of bearings, $14\frac{3}{4}$ inches each; length of spindle, 50 inches; distance between fields, 40 inches; spindle pulley, 6-inch face by 5-inch diameter; floor space over all, 22 by 50 inches. The Pratt & Whitney Company, 123 Liberty street, New York City, are the New York agents.

A New Locomotive Boiler Covering.

The accompanying cut shows a new fireproof covering recently brought out by the Kelley Company, of Mineral Point, Wis., to meet the want of master mechanics for a lagging for boilers that is



fireproof, that can be removed for repairs and again replaced, and that is cheap.

This covering is composed of strips of wood, treated in such a way as to be incombustible, and fastened together side by side so that every fourth strip is raised about one-half inch above the surface of the other three, these raised strips either being notched, as shown in the cut, or left whole. As this side is placed next to the boiler, it will, of course, form air spaces, which may, or may not, be filled with mineral wool, as desired. These strips have a backing of heavy paper board covered with asbestos paper, the whole being securely fastened together without nails or other metal fastening. It may thus be sawed or cut out to fit rivets or seams, and can also be made of any size to fit the sheets, and any curvature of the boiler. This covering is very strong, and may be walked on without injury. By means of the new patented device for fastening it on, any section of the covering may be removed at any time for repairs or examination and again replaced, without disturbing or loosening any other section. It gives a smoother surface for jacketing than wood lagging, and when it is further known that the cost is only about the same as that of wood, it will readily be seen that it is worthy of careful consideration.

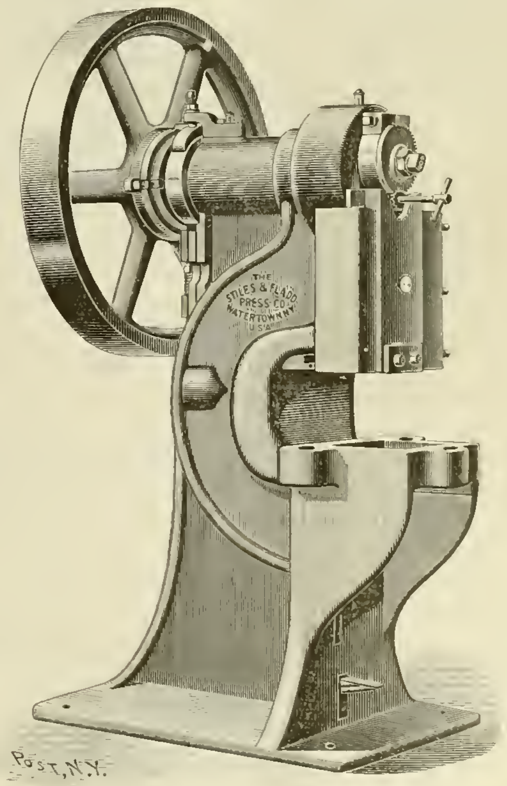
Improved Punching Press.

In the accompanying cut we illustrate a new punching press, which, while it follows in a general way the well-known Stiles press, embodies certain improvements. No great innovation can be introduced into a design of a punching press, in which a frame is in one solid casting, but the company putting this improved Stiles press on the market make their especial claim for excellence of workmanship and the selection of each separate kind of material of which the press is constructed.

Only a special mixture of iron of great strength is used in their castings and this mixture is continually tested and every care taken to keep it up to an established standard. Every part on which the slightest wear occurs is carefully scraped to an exact fit and a perfect bearing surface thereby provided.

The ways or guides of the slide are made exceptionally long to resist any side thrust without undue wear. The clutch adopted by this company to be used on this press in preference to all others, is one that has been perfected and recently patented by the inventor of the original Stiles clutch and Stiles press and is claimed to be superior in many ways to that well-known clutch. Among the special features we note the ability to run the press in either direction equally well; three points of contact in the wheel cause the clutch to be practically instantaneous; the operator can cause the press to make a whole revolution or only a part, as he may desire which is a valuable feature, as it prevents accidents to tools and operators, and makes this clutch absolutely safe. The clutch can be used to back out a punch that may become stuck in the die, and is claimed by the manufacturers to be the latest and best press clutch built.

These presses are manufactured by the Stiles & Fladd Press Company, of Watertown, N. Y., in six sizes weighing from 500 to



Stiles & Fladd Punching Press.

7,500 pounds, as fly presses, and in five sizes ranging in weight from 1,200 pounds to 8,000 pounds, as geared presses. The patterns are so constructed that an endless variety of modifications and changes can be made to adapt them to special work and tools of any make.

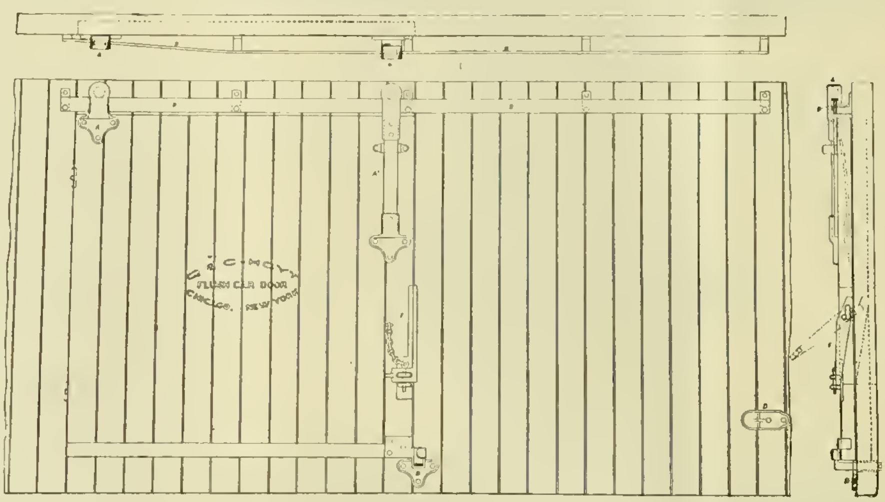
The Q & C Hoyt Flush Car Door.

The accompanying drawings show the new Q & C Hoyt Flush Car Door, which is being brought out by The Q & C Company. It will be noticed that there are several new features embodied in this door that are worthy of careful investigation, the first of which is an absolutely flush door, hanging from the top without a bottom rail of any kind. This entirely does away with any danger cf injury to the door at this point, besides reducing the weight and number of fixtures nearly one-half.

The parts needed at the top of the door are two hangers, the track and the track brackets, and the only parts used at the bottom of the door are a sliding guide bracket and catch which recedes into the sill of the car as the door closes. This is a novel feature in itself, which has been demonstrated to be thoroughly practical as nothing projects from the side of the car to be knocked off.

The locking device at the rear edge of the door is of such a design as to make it positively necessary to break the seal before the car can be entered. Besides this it acts as a leverage to throw the door into place and hold it there. The power of this lever is so great that it will throw a badly sprung door into its place with but little effort, making an absolutely storm-proof door.

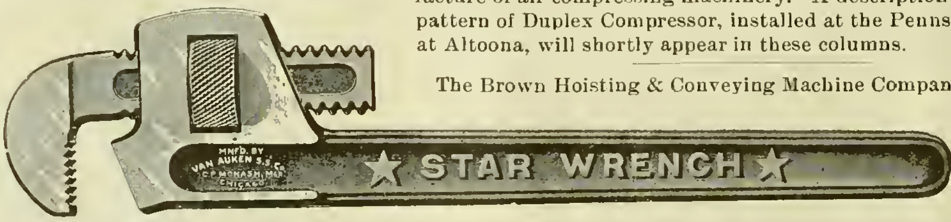
As a flush door it is claimed to be the cheapest in first cost, to have the least number of parts, to be easy to apply, and that the expense of maintenance is but very little, if anything.



The Q & C Hoyt Flush Car Door.

The Star Pipe Wrench.

The accompanying cut illustrates the star pipe wrench, which is manufactured by the Van Auken Steam Specialty Company, C. P. Monash, Manager, 203 South Canal street, Chicago. This wrench is simple in construction, having but three pieces, which are made with such care and unformity as to be perfectly interchangeable. It is claimed for this wrench that it does not stick on the pipe, but releases instautly, that it has no lost motion, that it cannot mash the pipe or slip off, and it is guaranteed never to strip, having an oval top thread. On account of the "slant" on the heel, it will also ratchet a nut or coupling without marring or rounding the corners.



A contract has been awarded by the Receivers of the Baltimore & Ohio Railroad Company to the Continuous Rail Joint Company, of Newark, N. J., for 50,000 rail joints.

Messrs. Bruner, Sprague & Co., 1027-8 Manhattan Building, Chicago, agents for the Sall Mountain, Georgia, asbestos, besides very flattering sales of their product to railroad for boiler covering, report a call for the asbestos from Japan.

The Gibbs Electric Company, 169 to 177 Clinton street, Milwaukee, Wis., have issued a number of illustrated sheets showing the different styles of motors which they build. Among these is a type M motor direct belted to a quartering machine, also a 20-horse power steel clad motor geared to a Hiles & Jones Company bar shear.

The Georgia Car and Manufacturing Company, of Savannah, will erect a plant to consist of an engine and boiler house, 75 by 109 feet; a machine, blacksmith and workshop, 106 by 375 feet; a building for the office; also warerooms, patterns and cabinet work, 106 by 150 feet; a shop for passenger cars, 106 by 500 feet, etc.

The Standard Car Wheel Company, of Cleveland, O., has been incorporated, with a capital stock of $75,000. The incorporators are: N. P. Bowler, of Bowler & Company; C. A. Brayton, formerly of Maher & Brayton; W. L. Bowler, W. B. Brayton and Francis J Wing. The new company has purchased the car wheel foundry of Bowler & Company.

If any of our readers do not thoroughly understand the new and simple method by which lead pipe can be coupled to lead pipe or to iron pipe instead of wiping or soldering the joints, they should write at once to The Van Auken Steam Specialty Company, 208 South Canal street, Chicago, for their illustrated catalogue of Star Lead-pipe Couplers and Fittings. In doing so please mention this journal.

The Clayton Air Compressor Works, Havemeyer Building, New York, report a gratifying increase iu their volume of business during the past few months, over the same period last year. The rapid extension in the field of application for compressed air was foreseen by these works several years ago, when they discontinued other lines and devoted their sole time and attention to the manufacture of air compressing machinery. A description of their latest pattern of Duplex Compressor, installed at the Pennsylvania shops at Altoona, will shortly appear in these columns.

The Brown Hoisting & Conveying Machine Company have closed a contract with the Pennsylvania Railroad for one Brown double cantilever machine for handling general merchandise on Pier J, Jersey City, to and from ocean steamers to cars. This machine has been designed especially for its location. It will hoist its maximum load of five tons 150 feet per minute, while the entire machine will be able to travel along the pier at the rate of 600 feet per minute. It is operated by steam and will be handled by a single operator. It is said to be the first machine specially designed for the rapid handling of freight to be erected in New York harbor.

The Chicago Rawhide Manufacturing Company, 75 East Ohio street, Chicago, Ill., have for the past eighteen years been manufacturing rawhide pinions. Their extended experience enables them to turn out a superior article—one that has met with the greatest success. The pinions are noiseless and greatly reduce the friction; furthermore, they do not wear out the meshing gear, yet they outwear metal pinions, thereby effecting a great saving in both directions. The company also make rawhide bell and register cord, remarkable for its strength and durability. Other products of their factory are leather belting, and rope for rope transmission. In connection with the latter they have a patented connection for making a splice without increasing the size of the rope, while retaining its full strength, thus overcoming a great objection to ordinary rope transmission, either by manilla or wire rope.

New Publications.

COMPRESSED AIR.—A monthly publication devoted to the useful application of compressed air. Published by W. L. Saunders, 26 Cortlandt street, New York. Subscription price, $1.00 per year.

This interesting periodical is only four months old, but it has developed wonderfully in that brief period. The rapidly extending use of compressed air for power purposes in all kinds of shops, in contractors' work, and in other lines too numerous to mention, gives this paper a large and growing field. From its pages it is evident that its editors and publisher are directing the attention of its readers to the thoroughly practical uses of compressed air and the most economical methods of employing that useful agent. That is just what is needed, and we can heartily commend the publication to those who are or ought to be interested in the compression, transmission or use of air.

HEALTH AND PLEASURE ON "AMERICA'S GREATEST RAILROAD." *Descriptive of Summer Resorts and Excursion Routes, Embracing more than One Thousand Tours by the New York Central & Hudson River Railroad.* Issued by the Passenger Department. New York; 532 pages; 6 by 9 inches. (Standard size.)

Each year the guide books which are published by the different lines of railroad are increased in size and elaborateness. The discoveries which have been made in the various processes of photo-engraving have facilitated very much the production of this class of literature, and have made possible a richness of illustration which our fathers never dreamed would be possible.

The volume before us has been issued by the passenger department of the New York Central Railroad, and is intended to set forth the attractions of that great line of travel.

At the beginning of the book is an excellent large folded map 3 ft. 3½ inches by 16 inches of the line and its connections from Boston to St. Louis. The different single-track roads are represented by one broad red line, double track by two and quadruple track by four.

The first chapter is devoted to a general description of the New York Central Railroad and its branches. The second chapter—33 pp.—to the Hudson River division and its environment, with a great many illustrations of interesting places and objects along and adjacent to the road. Among them are a number of historical scenes and much beautiful landscape.

The third chapter describes the Putnam division of the road, and the counties and places adjacent thereto. Excellent views are given of the High and Washington bridges in New York, buildings and scenes along the line of the road; some of them, such as the scene opposite p. 72, are of great beauty. Following this chapter is one of 34 pp. devoted to the Harlem division, and containing many admirable illustrations. "The Beautiful Mohawk Valley" is the title of the succeeding chapter, and embraces that part of the line from Albany to Utica. Other chapters describe the Lake Region of Central New York, the Auburn road, Rochester to Buffalo and Niagara Falls, Rochester and Niagara Falls road, the Adirondack Mountains, with a multiplicity of views of lakes, mountains and hotels. About 70 pp. are devoted to descriptions of places which may be reached by the New York Central road. The terminal facilities in New York are described, and about 90 pp. are given up to information concerning steamboat and stage lines, followed by schedules which relate directly or indirectly to the great road which is the subject of this elaborate volume.

About 50 pages are devoted to tables, giving rates of fare, lists of hotels and boarding-houses along the line, and much other information of interest to travellers. Over 100 pages of very interesting advertisements complete the book.

It is not easy in a brief notice like this to give an adequate idea of the wealth of illustrations which are given. The mere enumeration of them would take a great deal of time. It is safe to say that there are several hundred. Most of them are of a very excellent character of engraving. A number of them—as for instance that on page 140, "Great Expectations,"—have much artistic merit.

The style of the descriptive matter is very pleasant, and there is a grateful absence of the guide-book style, which in some productions of this kind is so "averting." The price of the book is 25 cents, and is the cheapest publication we know of for the money. The fault to be found with it is that its perusal produces a desire—which is difficult to resist—to pack up and take an early train to some of the agreeable places which are described.

Our Directory

OF OFFICIAL CHANGES IN JUNE.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Mr. D. B. Robinson has resigned the office of First Vice-President.

Baltimore & Ohio.—Mr. E. L. Weisgerber, formerly Master Mechanic at Newark, O., has been transferred to the position of Master Mechanic of the Mont Clare shops, Baltimore. Mr. Wm. Harrison, Jr., succeeds him at Newark. Mr. H. N. Woodward has been appointed Master Mechanic at Parkersburg to succeed Mr. J. H. Irvin, assigned to other duties.

Brainerd & Northern Minnesota.—Mr. O. O. Winter has been appointed General Manager, with headquarters at Brainerd, Minn.

Chesapeake, Ohio & Southwestern.—Gen. J. Echols, Receiver and General Manager, died May 24. Mr. St. John Boyle has been made sole Receiver, and will act as General Manager until the road is turned over to the Illinois Central.

Georgia Northern.—Mr. Archie McLean has been appointed Superintendent of Motive Power, with headquarters at Pidcock, Ga., vice Mr. A. Marugg, resigned.

Great Northern.—Mr. W. W. Finley has been elected Vice-President and General Manager. Mr. J. E. Cannon has been appointed Master Mechanic at Barnesville, Minn.

Houston, East & West Texas.—T. W. House has been chosen President.

Litchfield, Carrollton & Western.—Mr. C. B. McCall has been made General Manager, with headquarters at Carlinville, Ill., vice Mr. T. D. Hinchcliffe, resigned.

Long Island.—Mr. George S. Edgell has been elected second Vice-President. Mr. Austin Corbin, President, was killed in an accident last month.

Louisville, Evansville & St. Louis.—Mr. D. L. Anderson has been appointed Secretary and Purchasing Agent, with headquarters at Evansville, Ind. Mr. W. E. Looney has resigned the position of Master Car Builder, and the office is abolished.

Louisville, St. Louis & Texas.—Mr. W. V. McCracken has retired from the Presidency, and is succeeded by Mr. Attilla Cox. The reorganized road will be known as the Louisville, Henderson & St. Louis Railroad.

Manhattan.—Mr. Wm. J. Fransioli has been appointed Acting-General Manager, vice Col. F. K. Hain, deceased.

Midland Terminal.—Mr. F. Singer has been appointed Master Mechanic, with headquarters al Gillett, Col.

Montana Central.—Mr. C. H. Warren has resigned the position of General Manager. The road will not be operated hereafter by the Great Northern, but will have it own corps of officials.

New England.—C. P. Clark has been appointed Assistant General Manager, and will perform the duties heretofore performed by the General Manager. Office, 180 Summer street, Boston.

New Orleans & Western.—J. M. Turner. Superintendent of Motive Power, has been appointed General Manager. C. B. Deasom has been appointed Chief Engineer.

Northern Pacific.—Mr. Ed. M. Winter has been elected President.

Ohio River.—Mr. H. H. Rogers has been chosen President.

Pittsburgh & Lake Erie.—Mr. J. M. Schoonmaker has been chosen Vice-President, to succeed Mr. J. H. Reed, resigned.

Pittsburgh & Western Railway.—Frank T. Hyndman has been ppointed Master Mechanic, vice I. N. Kolbaugh, resigned.

Sherman, Shreveport & Southern.—Mr. F. W. Fratt has resigned the position of General Manager and the duties of the office will devolve upon the Superintendent.

St. Louis & San Francisco.—Mr. D. B. Robinson has been elected President, with headquarters at St. Louis.

Stuttgart and Arkansas River R. R.—S. W. Fordyce is Receiver. H. E. Martin is Manager for Receiver.

Wiscasset & Quebec.—Mr. R. T. Rundlett has resigned the position of President and General Manager. Mr. H. Ingalls has been elected President, and Mr. W. F. P. Fogg, General Manager.

Exhibits at the Conventions.

The exhibits at the conventions were larger and more numerous than on any previous year and were worthy of careful and minute inspection and study. The following is a complete list of them:

Adams & Westlake Company, Chicago; curtain fixtures, etc. Represented by L. A. Gray, T. B. Jones and H. E. Keeler.

Alexander Car Replacer Manufacturing Company, Scranton, Pa.; steel engine and car replacers. Represented by E. B. Whitcomb.

American Balance Slide Valve Company, San Francisco, Cal., and Jersey Shore, Pa.; slide valves. Represented by J. T. Wilson.

American Brake Beam Company, Chicago; Kewanee brakebeam. Represented by E. G. Buchanan and J. G. Sanborn.

American Steel Foundry Company, St. Louis; car trucks, bolsters, cast steel locomotive frames, couplers and steel castings in general. Represented by C. B. Evans, J. W. Robinson, E. F. Goltra.
American Steel Castings Company, Thurlow, Pa.; cast-steel driving wheel centers, locomotive frames and other steel castings. Represented by D. Egan, S. A. Watson and W. A. Blanchard.
Armstrong Bros., Chicago; machinists' tools and supplies. Represented by P. Armstrong.
Ashton Valve Company, Boston; safety valves and steam gages. Represented by F. A. Casey.
Automatic Dumping Car Company, New York; door-operating device for hopper-bottom cars. Represented by Wm. McMahon.
Boston Belting Company, Boston; rubber goods. Represented by Geo. H. Forsyth, J. F. Muldoon, Fred T. Alden, T. R. Freeman.
Burrows Company, E. T., Portland, Me.; car curtains. Represented by Harry H. Russell.
Brown Automatic Car Coupler Company, Columbus, Ind.; car couplers. Represented by W. G. Irwin and P. C. Brown.
Barbey & Company, F. A., Boston; Hampson flexible steam joint. Represented by F. A. Barbey.
Buckeye Malleable Iron & Coupler Company, Columbus, O.; Little Giant Coupler. Represented by J. E. Howe, J. Timms, C. D. Bailey, C. H. McKibbin and R. C. Fraser.
Bundy Manufacturing Company, Binghamton, N. Y.; time recorder. Represented by H. E. Bundy and C. J. Morehouse.
Bushnell Mfg. Company, Easton, Pa.; car seats. Represented by E. Bushnell and C. Pullman.
Bourne, E., Vancouver, B. C.; Fader dump car.
Baker, William C., New York; car heater. Represented by W. C. Baker and J. G. Demarest.
Bird & Son, F. W., East Walpole, Mass.; car roofing. Represented by M. A. Garrett.
Boston Woven Hose and Rubber Company, Boston; rubber goods. Represented by A. L. Whipple, Jr.
Bridgeport Car Equipment Company, Bridgeport, Conn.; third rail system for electic cars.
Brussells Tapestry Company, Chauncey, N. Y.; car window and berth curtains, mattresses, rugs, head linings and the "Perfect" self-adjusting curtain fixture. Represented by W. S. Calhoun.
Brill Company, J. G., Philadelphia; model of truck. Represented by L. B. Smyser.
Bruner, Sprague & Company, Chicago; asbestos lagging for locomotives, fire-proofing and insulation for cars. Represented by H. C. Bruner and J. H. Sprague.
Chase & Company, L. C., Boston; plush goods. Represented by R. Bishop, Jr.
Chicago Grain Door Company, Chicago; grain door and security lock bracket. Represented by J. L. Mallory.
Chicago Pneumatic Tool Company, Chicago; pneumatic hammers, sand-papering machines, piston air drills, air hoists, flue expanders, pneumatic belt shifters, and other pneumatic devices. Represented by J. W. Duntley, W. O. Duntley, J. F. DeGarmo, I. W. Davis and J. Boyer.
Chicago Railway Equipment Company, Chicago; National Hollow brake-beam. Represented by E. B. Leigh, A. J. Farley, L. C. Burgess and F. Ely.
Consolidated Car-Heating Company, Albany, N. Y.; Pope light. Represented by C. A. Sheldon, J. F. McElroy, W. N. Stevens, R. P. Scales, W. P. Cosper and F. P. Foley.
Carnegie Steel Company, Pittsburgh; steel cars. Represented by T. C. Carson, George H. Wightman, H. M. McIlwain, H. J. Lindsay and J. B. Hardie.
Crown Car Coupler Company, Troy, N. Y.; car coupler. Represented by F. Waller and G. H. Mowers.
Crosby Steam Gage and Valve Company; gages and valves. Represented by E. C. Bates.
Detrick & Harvey Machinery Company, Baltimore, Md.; bolt-cutting machinery. Represented by T. M. Brown.
Davis Car Shade Company, Portland, Me.; car shades. Represented by E. E. Piper and C. M. Fuller.
Eureka Nut Lock Company, Pittsburgh; nut locks for car construction. Represented by S. D. Barnett.
Evans Artificial Leather Company, Boston, Mass.; leather substitute for upholstering car seats. Represented by W. N. Dole and A. E. Prince.
Falls Hollow Stay Bolt Company, Cuyahoga Falls, O.; stay bolts and stay-bolt iron. Represented by C. M. Walsh and J. W. Walsh.
Foster Engineering Company, Newark, N. J.; governors, reducing valves, automatic safety stop valves, inside injector checks and reducing valves. Represented by J. M. Foster.
French Renovating Process Company, Cleveland, O.; process for cleaning car plushes. Represented by H. Stern.
French Spring Company, Pittsburgh; box lids and springs. Represented by L. C. Noble and Geo. Morris.
General Agency Company, New York; Smith triple expansion exhaust pipe. Represented by C. A. Ball, J. Y. Smith and J. R. Ellicott.
General Electric Company, Schenectady, N. Y.; photographs of motors. Represented by W. J. Clark, L. H. Parker, C. C. Pierce, F. H. Shepard and W. B. Potter.
Gold Car Heating Company, New York; system of car heating. Represented by E. E. Gold and E. H. Gold.
Goodwin Car Company, Chicago; model, drawing and photographs of the Goodwin dump car. Represented by J. M. Goodwin, G. T. Plowman and N. Seubert.
Gould Car Coupler Company, New York; freight and passenger couplers and spring buffer blocks for freight cars. Represented by C. M. Gould, Dr. C. W. Gould, A. Dowdell, W. F. Richards, F. P. Huntley and Geo. E. Widner.
Gifford Car Coupler Company, Chicago; car coupler. Represented by M. R. Clapp.
Gisholt Machine Company, Madison, Wis.; tool-grinder. Represented by F. V. Bartlett, W. H. Kruse and F. H. Robinson.
Grady, M. J., Kingston, Ont., car coupler. Represented by M. J. Grady.
Greeley & Company, E. S., New York; Acme packing waste. Represented by E. B. Eaton.
Hammett, M. C., Troy, N. Y.: Corey Force Feed Oiler, pneumatic bell ringer, guide and rod oil cups, Richardson balance valves. Represented by M. C. Hammett.
Hicks, John B., New York; Bellamy filler, R. I. Clark & Company's varnishes and japans, and New Jersey Car Spring and Rubber Company's hose, etc. Represented by J. B. Hicks and C. L. Bellamy.
Hale & Kilburn Manufacturing Company, Philadelphia; car seats. Represented by H. S. Hale, C. E. Barrett and H. T. Bigelow.
Hancock Inspirator Company, Boston; inspirators. Represented by C. E. Randall and T. Aldcorn.
Harris, E. W., Palisade, Nev.; variable exhaust nozzle.
Hodge & Company, Samuel, Detroit; McCoy sight feed lubricators. Represented by E. McCoy.
Haeseler Company, The C. H., Philadelphia; portable pneumatic tools.
Ingersoll-Sergeant Drill Company, New York; triplex, two-stage steam air compressor and and 8 by 8 belt-actuated compressor. Represented by C. W. Shields.
Interchangeable Brake Beam Company, St. Louis; brake beam. Represented by J. C. Stewart and E. H. Power.
Jerome Metallic Packing Company; Jerome packing and McIntosh "duplex" blow-off cock. Represented by G. C. Jerome.
Johns Manufacturing Company, H. W., New York; asbestos fire-felt boiler and pipe covering, car roofing, paints, vulcabeston packing. Represented by F. M. Patrick.
Jenkins Brothers, New York; Jenkins 1896 valves, Sellers injectors. Represented by J. D. Stiles and C. W. Martin, Jr.
Kanaly Company, M. E., Cambridgeport, Mass.; Standard car-door hanger. Represented by M. E. Kanaly.
Kinzer & Jones Manufacturing Company, Pittsburgh; composition brake shoes. Represented by J. J. Kinzer and Wm. Weierback.
Keasbey & Mattison Company, Ambler, Pa.; magnesia boiler covering. Represented by W. W. Johnson and G. Rose.
Knitted Mattress Company, Canton Junction, Mass.; knitted mattresses. Represented by G. F. Summer.
Leach, H. L., Boston; track sander.
Lewis Tool Company, New York; vices. Represented by E. T. Leevenworth.
Look, J. C., San Jose, Cal.; unlocking lever for couplers.
Major A., New York; filter and cement.
Manning, Maxwell & Moore, Ashcroft Manufacturing Company, Consolidated Safety Valve Company, Hayden & Derby Manufacturing Company; Ashcroft steam gages, Muffler pop valves, encased locomotive valves, Tabor indicator, Metropolitan injector, and Manning, Maxwell & Moore tools. Represented by C. A. Moore, J. N. Derby, J. N. Gardner, A. C. Stebbins, R. A. Bole, D. W. Pedrick and F. T. Tapley.
Massachusetts Mohair Plush Company.
McKibben & Company, C. H., New York. Represented by C. H. McKibbin, Chas. D. Bailey, R. C. Fraser.
Moran Flexible Steam Joint Company, Louisville, Ky.; steam joint. Represented by H. U. Frankel and T. W. Moran.
More, Jones & Company, St. Louis; car and engine brasses. Represented by F. A. Johann.
Morris Box Lid Company, Pittsburgh; box lids. Represented by Geo. Morris.
Motley & Company, Thornton N., New York; the LeBel electric kindler. Represented by W. W. Caldwell.
New York Belting and Packing Company; rubber goods. Represented by A. F. Conklin.
Norton, A. O., Boston; jacks.
New York Rubber Company, New York; rubber goods. Represented by Frank Scofield.
National Malleable Castings Company, Cleveland; Tower coupler, National car-door fasteners, Eubank doors and malleable castings for cars. Represented by Willard A. Smith, C. L. Sullivan, S. L. Smith, J. V. Davison, F. R. Angell and F. B. Whitlock.
National Car Wheel Co., Buffalo; car wheels. Represented by W. W. Turlay.
National Machinery Company, Tiffin, O.; blue prints of machines. Represented by F. Bloom.
National Car Coupler Co., Chicago; the national coupler. Represented by J. Hinson.
New York Coupler Company, New York; car coupler. Represented by P. H. Wilhelm.
One-Piece Drawbar Company, Chicago; Deitz tender passenger and freight couplers and Ogden train jack. Represented by H. Deitz.
Pugh, Joh T., Philadelphia; drills, augers, etc.
Peerless Rubber Manufacturing Company, New York; rubber goods. Represented by C. H. Dale, C. S. Prosser and W. J. Courtney.
Pedrick & Ayer, Philadelphia; automatic belt air compressors, air lifts, pneumatic grinding and drilling machines, pneumatic riveter, pneumatic chipping and calking tools. Represented by D. W. Pedrick, C. H. Haesler and Howard A. Pedrick.
Plush Renovating Company, Baltimore; process for cleaning plushes. Represented by Chas. H. Winkelmann and H. E. Wilkens.
Q. & C. Company, Chicago; McKee brake adjuster, Williams locomotive valve-setting device and Q. & C. flush door. Represented by C. F. Quincy, F. Ely, E. W. Hodgkins, F. E. Came and J. K. Lencke.
Railroad Supply Company, The, Chicago; the Hein double automatic coupler and car jack. Represented by Phil Hein, C. A. Herriman.
Reliance Replacer Company, Jersey Shore, Pa.; wrecking frogs.
Revere Rubber Company, Boston; rubber specialties. Represented by W. B. Miller, George Q. Hill, W. B. Miller, Wm. Killmer, T. A. Budd, E. Z. Jefferson, John W. Teller, George A. Gardner and Richard Kutzleb.

Ross Valve Company, Troy, N. Y., valve. Represented by Wm. Ross.
Ruth Equipment Company, Pittsburgh; sleeping-car berths with pneumatic cushions, etc. Represented by L. F. Ruth, J. B. Ruth and George Miller.
Star Brass Manufacturing Company, Boston; track sanders, pop safety valves, steam gages, whistles, air-brake and inspector's gages. Represented by C. W. Sherburne and E. C. Sawyer.
Safety Car Heating and Lighting Company, 160 Broadway, N. Y.; the Pintsch light. Represented by A. W. Soper, Robert Andrews, R. M. Dixon, M. P. Stevens, E. F. Slocum and O. C. Gayley.
Sewall, J. H., Worcester, Mass; "Standard" brake slack adjuster.
Shickle, Harrison & Howard Iron Company, St. Louis; cast-steel body and truck bolsters. Represented by T. M. Gallagher.
Sams Automatic Car Coupler Company, Denver, Col.; model couplers on model cars. Represented by C. G. Burkhardt and L. D. Sweet.
Smith & Company, Edward, New York; preservation of metal surfaces. Represented by A. Johnson and E. H. B. Twining.
Standard Steel Works, Philadelphia; locomotive tires, steel tired locomotive and car wheels. Represented by M. Middleton, C. Riddell and T. L. Courtney, Jr.
Springfield Malleable Iron Company, Springfield, O.; Miner and Bryan draft rigging and the Ludlow freight, passenger and tender couplers. Represented by R. Ludlow, J. T. Ricks and A. Ludlow.
Schirra Seal Company, Pittsburg; car seals. Represented by Schirra and G. Fivel.
Schoen Pressed Steel Company, Pittsburg, Pa.; pressed steel bolsters. Represented by C. T. Schoen and J. T. Milner.
Smillie Coupler Company, Newark, N. J.; car coupler. Represented by C. H. Taylor.
Smart Car Door Company, Nashua, N. H.; flush car door. Represented by H. D. Smart.
Taylor Iron & Steel Company, High Bridge, N. J.; Taylor steel tired wheels. Represented by W. J. Taylor.
Taylor Company, N. & G., Philadelphia, tinplate and Pancoast ventilator. Represented by M. J. Cusick.
Tilden Company, B. E. Chicago; wrecking frog. Represented by B. E. Tilden.
Trojan Car Coupler Company, Troy, N. Y.; car coupler. Represented by A. H. Renshaw, H. N. Loomis, W. C. DeArmond and E. Dietz.
Universal Construction Company, Chicago; Harvey and Pennock steel cars. Represented by W. R. Stirling.
Universal Safety Car Bearing Works, Jersey City, N. J.; Baker's universal safety car bearings. Represented by J. R. Baker.
Vose & Cliff Manufacturing Company, New York; King's yielding side bearings. Represented by E. Cliff.
Whitman & Company, Clarence, New York; Pantasote, a substitute for leather. Represented by H. E. Twining and H. M. Grier.
Western Railway Equipment Company, St. Louis; Houston locomotive track sander, combination lug and follower, economy slack adjuster and American journal box. Represented by E. S. Marshall.
Wilson & McIlwain, Pittsburg; Clancy's hose clamp, Wadsworth, Howland & Company's paints, Wells lights, Keystone soft metal unions, Sewall's brake slack adjuster, and Hutchins' roof. Represented by J. T. Wilson and J. D. McIlwain.
Wolstencroft's Sons & Company, Wm., Philadelphia; pneumatic hammers. Represented by G. B. Harris and Wm. H. Curtis.
Yerdon, Wm., New York; double hose band. Represented by Wm. Yerdon.
Zenner-Raymond Disinfectant Company, Detroit, Mich.; disinfectant. Represented by A. H. Zenner.

Souvenirs at the Conventions.

As usual, there were a number of souvenirs distributed at the conventions. We only have room to publish a list of them, without attempting descriptions, though many of them are worthy of praise:
American Brake Company, St. Louis; views of the destruction wrought by the St. Louis tornado.
Boston Belting Company, Boston; glass paper weights, pen wipers and whist counters.
Brown Hoisting and Conveying Machine Company; pass books.
Brown & Sharpe, Providence, R. I.; three-inch scales.
Buckeye Malleable Iron and Coupler Company, Columbus, O.; pocket knives.
Ewald Iron Company, St. Louis; paper cutters.
Flood & Conklin Company, Newark, N. J.; pocketbooks.
Foster Engineering Company, Newark, N. J.; trick match safes.
Jenkins Brothers, Jersey City, N. J.; whist counters.
Morris Box Lid Company, Pittsburgh, Pa.; corkscrews.
National Machinery Company, Tiffin, O.; match safes.
Peerless Rubber Manufacturing Company, New York; pocket knives.
Pocket List of Railroad Officials, 326 Pearl street, New York; 12-inch folding steel rules.
Pratt & Lambert, 47 John street, New York; note books with aluminum covers.
Revere Rubber Company, Boston; glass paper weights.
Safety Car Heating and Lighting Company, 160 Broadway, New York; card cases.
Smillie Coupler & Manufacturing Company, Newark, N. J.; note books.
Standard Paint Company, 81 John street, New York; note books.
T. Prosser & Son, 15 Gold street, New York; playing cards.
W. W. Laurence & Co., Pittsburgh, Pa.; lead pencils in the form of a hollow nail containing adjustable leads.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Twenty-Ninth Annual Convention.

Exhaust Pipes and Steam Passages.

ROBT. QUAYLE, WM. FORSYTH, J. MCNAUGHTON, W. S. MORRIS, D. L. BARNES, PROF. W. F. M. GOSS, Committee.

The work was outlined by the committee, as follows:

First. Determine the angle of the exhaust steam jet.

Second. The effect of the shape of the orifice on the angle and shape of the jet.

Third. Determine the effect of height of bridge on the direction of the individual jet.

Fourth. Vary height of nozzle with best form of orifice and height of bridge, as determined by tests two and three, from the highest to the lowest practicable point, with the form of stack recommended by last year's committee.

Indicator cards to be taken to also determine the effect of change of form of orifice on the back pressure in the cylinder.

Fifth. Vary the length of the stack recommended by last year's committee, with nozzle located at the most efficient point as determined by the fourth test.

Sixth. Vary the heights of straight stack that last year's committee recommended, nozzle located the same as in fifth test.

Seventh. Vary the size of the nozzle with the best arrangement of parts, as already determined.

Eighth. Comparative results of double and single nozzles.

It was agreed that work under the first three points should be undertaken in connection with the locomotive testing plant of Purdue University, at Layfayette, Ind., and that the remainder of the work should be done in connection with the testing plant of the Chicago & Northwestern Railway, at West Chicago shops. This division gave to the Purdue University the study of the form and density of the exhaust jet (Part I), and to the Northwestern the study of its efficiency, as effected by all the various changes suggested by the outline (Part II).

PART I.

FORM AND CHARACTER OF THE EXHAUST-STEAM JET.

The methods employed in this study and the apparatus used were practically the same as described by Professor Goss before the Western Railway Club, in October, 1895, in his paper, "A Glimpse of the Exhaust Jet." The conclusions from these investigations are given by the committee as follows.

1. The action of the exhaust jet within the stack is not that of a piston within the barrel of a pump.
2. Draft can as well be produced by a steady flow of steam as by the intermittent exhaust jet.
3. The exhaust jet, under ordinary conditions, does not fill the stack until near its top.
4. The vacuum within the stack at points near its base is greater than that within the smokebox.
5. The jet acts upon the smokebox gases in two ways; first, by frictional contact it induces motion in them, and second, it enfolds and entrains them.
6. In all jets examined the induced action was relatively strong and the entraining action weak.
7. Any condition which will tend to solidify or to reduce the spread of the jet appears to affect favorably its efficiency.
8. Changes in stack proportions may greatly affect the form of the jet.
9. In general, a change in the amount of steam discharged will change the form of the jet, the spread being reduced as the volume of steam is increased.
10. Other things being the same, the form of the jet is not much affected by changes in speed or of cut-off.
11. The form of the nozzle has much to do with the form of the jet, and hence with its efficiency.

The experiments of the committee disprove the pump-action theory of the exhaust. They show that the jet of steam does not fill the stack at or near the bottom; that under certain conditions common to practice it touches the stack only when it is very near the top; and finally, that a jet of steam flowing steadily from the exhaust tip, the engine being at rest, results in draft conditions which are in every way similar with those obtained with the engine running, the same amount of steam being discharged per unit of time in each case. These facts will doubtless be accepted as proof of the statement that the smokebox gases are not forced out by the action of the steam jet.

Enough has not yet been done to define the precise action of the jet, but it may be said with certainty (1) that it acts to induce motion in the particles of gas which immediately surround it, and also (2) that it acts to enfold and entrain the gases which are thus made to mingle with the substance of the jet itself.

It is clear that any design of nozzle which will serve to subdivide the stream, or to spread it so as to increase its cross-section, will assist the jet in its effort to entrain the gases, but it is not clear that there is any gain to be realized in such a result. It is possible that, as the mixing action is increased, the induced action may be diminished, and that the sum total of the effect produced may remain nearly constant. The work which has thus far been done is not conclusive on this point, but the evidence tends to show that the more compact and dense the jet, the higher its efficiency.

Interesting diagrams of the form of the exhaust jet at different speeds, with various nozzles, and several different inside diameters of stacks are presented by the committee. A comparison of the form and location of similar lines in different jets shows the effects produced by the different combinations of pipes, nozzles, etc., which were experimented upon. While making such a comparison, it is of interest to remember that a vacuum gage attached to the side of the stack at a point 13 inches above its base always gave about one and one-half (1.5) times the vacuum recorded by the smokebox vacuum gage; and that a second gage attached within 10 inches of the top of the stack gave a vacuum approximately equal to six-tenths (0.6) of the vacuum in the smokebox. The diagrams show that increased speed results in less spreading of the jet, and a better vacuum, but the latter is due to the greater volume of steam passing, and not to the rapidity of the exhaust impulses.

By blocking the slide valves clear of their seats and opening the throttle slightly the committee were enabled to cause a steady blow through the exhaust in which the weight of steam passed was practically the same as in some of the trials of the regular jet. The results, as already stated, show that there is no essential difference in the effects of the two kinds of jets.

The portion of the exhaust pipe above the top of the bridge serves to combine and to straighten the jet. The lower the bridge the greater the length of this combining or straightening pipe, and a more dense and compact jet is delivered from the nozzle. A nozzle ending in a plain cylindrical portion two inches in length gave better results than either a nozzle contracted in the form of a frustum of a cone, or a nozzle in the form of a plain cylinder ending in an abrupt cylindrical contraction, the jet from the first-named nozzle being more solid and efficient.

A false "chock," reducing the diameter of the stack from 16 inches to 12 inches, widens the angle of the lower part of the jet, the outer walls of which it especially affects. The chock acts as a throttle on the delivery of the combined stream of gases, and by so doing produces a material reduction in the velocity of currents of gas and steam within the smokebox for points about the jet and immediately below the stack; this reduced velocity allows the steam jet to "upset," or broaden.

PART II.

These tests were made on the Chicago & Northwestern testing plant at the West Chicago shops, with engine 797, a ten-wheel Schenectady locomotive, with 19×24 inch cylinders, 56-inch driving wheel centers, having an eight-foot firebox, 40¾ inches wide, located on top of the frames. The engine was fitted with five draft gages, two at the smokebox and three at the firebox; a Boyer speed-recorder; two Bristol recording gages, one showing the boiler pressure, and the other connected to the exhaust cavity in the left cylinder saddle. Indicator cards were taken from both cylinders, those from the left side being taken with a 100-pound spring, while on the right side a 10-pound spring was used and the piston provided with a stop at 20 pounds in order to show the back pressure accurately. Constant conditions in the firebox could not be obtained with coal and the grate was therefore blocked with firebrick except an opening of about 189 square inches, and petroleum used for fuel.

The actual work performed was not exactly that outlined by the committee, as more work than was anticipated was found to be necessary to determine the best features of the design of an exhaust pipe, and, in consequence, some of the work on stacks as outlined in parts five and six was not reached.

The work on this testing plant relates principally to the proper design of an exhaust-pipe and nozzles for maximum efficiency, and the results obtained are believed to confirm the following conclusions, all of which are established only within the limits of the experiments, and for the arrangement of smokebox, boiler and flues used in the tests:

First. The exhaust-pipe should be as short as possible with a proper arrangement of diaphragm and netting, provided this does not make it less than 19 inches high, which was the lowest limit tested.

Second. The bridge in this pipe should not be less than 13 inches high.

Third. The area of each of the openings of the pipe at the most contracted part should be not less than the area of the nozzle. (This conclusion may only be true for the pareicular form of pipe and location of the choke used in the above experiments.)

Fourth. When it is necessary to reduce the area of the exhaust opening, it should be done at the nozzle and not at the choke.

Fifth. The nozzle should be raised when necessary by lengthening the portion of the pipe above the top of the bridge, rather than below.

Sixth. The exhaust tip ending in a plain cylindrical portion 2 inches in length in these tests gives better results than either a nozzle contracted in the form of a frustrum of a cone or a nozzle in the form of a cylinder with an abrupt cylindrical contraction at the orifice.

Seventh. The distance from the choke of the stack to the nozzle for 14-inch choke stack 52 inches long should not exceed 50 inches, nor be less than 40 inches for maximum efficiency.

Eighth. The distanec from the top of the smoke arch to the nozzle with 14-inch straight stack 52 inches long. should not be greater than 38 inches nor less than 23 inches.

Ninth. The distance from the top of the smoke arch to the exhaust nozzle, with a 16-inch straight stack 52 inches long, should not be greater than 38 inches nor less than 28 inches.

Tenth. The efficiency of the steam jet is reduced by spreading it by means of cross bars in the nozzle.

Eleventh. Cross-bars not wider than ⅜-inch placed in the nozzle or above it nearer than 1 inch increase the back pressure; wider cross-bars increase the back pressure when further removed in proportion to their width.

Twelfth. A petticoat pipe with the single nozzle, when properly arranged, increases the efficiency of the jet.

Thirteenth. Double nozzles, with 14-inch choke stack and 16-inch straight stack 52 inches long, are not as efficient as single nozzles, the difference being very slight.

Fourteenth. Double nozzles should be located with reference to the stack the same as single nozzles.

Conclusions from the Von Borries-Troske tests (see AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for March and May, 1896) on the effect of various lengths of conical and cylindrical stacks.

Fifteenth. The maximum height of stack, measured from the exhaust nozzle, if the diameter at the choke is properly chosen, need not exceed five times this diameter. For cylindrical stacks the ratio of diameter to height is the same.

Sixteenth. The vacuum increases as the stack is shortened and more rapidly with cylindrical than with conical stacks.

Seventeenth. The decrease in vacuum due to shortening the stack within certain limits can be nearly overcome by lowering the nozzle. The amount which the nozzle should be lowered with cylindrical stacks is almost equal to the amount the stack is shortened. With conical stacks the nozzle should be lowered about two-thirds as much as the stack is shortened.

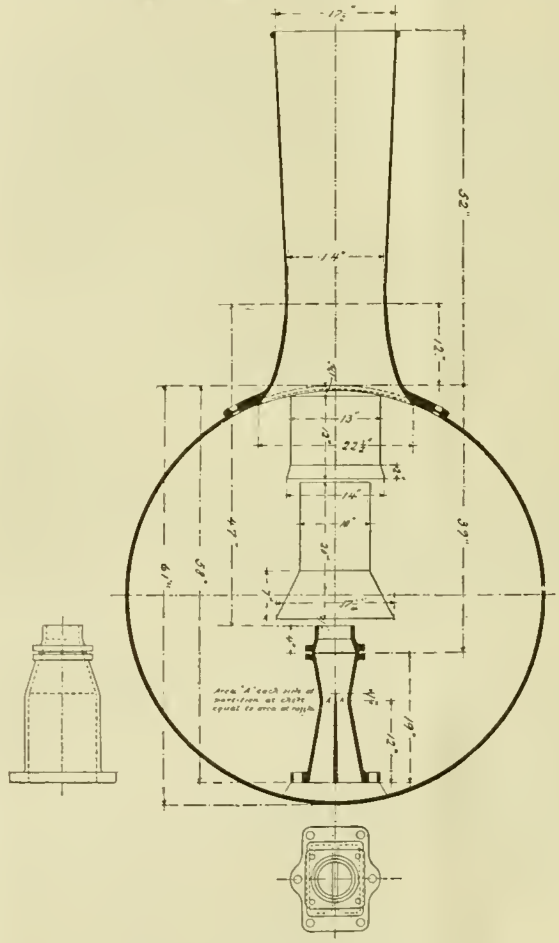


PLATE 48.

Plate 48 shows the arrangement of exhaust pipe, nozzle, petticoat pipe and stack, which gave the best general results as to vacuum and efficiency in the committee's tests. An inspection of the results of the tests in Part II. will show that certain variations from the above change but slightly the effectiveness of the draft appliance. The limits within which the different parts experimented with can be changed without materially affecting the efficiency of the apparatus as a whole are as follows:

First. Height of the bridge should not be lower than that shown, although lowering it decreases the efficiency but little.

Second. Distance of the nozzle from the choke of the stack can be from 49 inches to 39 inches, preferably nearer the former than the latter.

Third. The area of each opening at the choke of pipe can be decreased below the area of the nozzle as much as 20 per cent., without greatly decreasing the efficiency at speeds and cut-offs experimented with. Preference to the larger opening should be given with engine working generally at short cut-offs.

Fourth. The petticoat pipe can be made to considerably increase the efficiency of the draft apparatus in boilers of this diameter and probably larger, but it must be carefully adjusted to the exact draft conditions of the engine. This can probably only be done with the engine in actual service. In boilers of smaller diameter, a petticoat pipe is probably of little or no service. The committee's tests are not sufficiently comprehensive to give the limits of this adjustment. They indicate, however, that the top of a 13-inch top section should not be higher than 2 inches below the top of the smokebox with 14-inch choke or 16-inch straight stack.

Fifth. The 14-inch choke stack could probably be shortened without materially affecting the vacuum. By how much, the committee's tests do not show. A straight stack must be larger than 14 inches diameter, but neither 14-inch nor 16-inch straight stacks give as good results as the choke stack, although the 16-inch straight stack shows much better results than that 14 inches in diameter.

Slide Valves.

G. R. Henderson, W. H. Thomas, E. E. Davis, Philip Wallis, L. R. Pomeroy, Committee.

Your committee on "Slide Valves" was given two problems to solve: 1st, To consider different types of balanced valves, and to determine their economy and efficiency over plain unbalanced valves; and 2d, To determine the economy and efficiency of Allen ported valves over plain valves.

BALANCED VALVES.

This report will deal only with such styles of balanced valves as are now in actual service on railroads. From the replies to the circular of inquiry (constituting only 52 out of the total membership of over 600) we find that of 10,934 locomotives on 50 roads, 7,241 are equipped with balanced valves of some type, and that 145 have piston valves, the latter mostly on compounds. The balanced valves are distributed about as follows:

Richardson	5,915	Delaney	42
Morse	482	Margach	30
Barnes	288	Leeds	8
American	287		

In regard to the amount of balance used on the valves, there was a great variety in the statements, which ran from 48 per cent. to 95 per cent. of the total valve area, though the greatest number, by far, gave between 55 per cent. and 65 per cent. of the total valve area.

The valves tested by your committee had balance areas as follows.

	Square inches.	Per cent.
Richardson valve	97.95	56
Sin bal. American	99.40	61½
Double bal. American	106.90	66

It should be borne in mind, however, that the taper of the American rings, with steam pressure on the outer circumference, will tend to force the valve down on the seat, overcoming in part the much larger balancing area.

The answers to the question relative to the wear of seats and valves per unit of distance indicated that a wear of from $\frac{1}{32}$ inch to $\frac{1}{16}$ inch per 100,000 miles might be expected with balanced valves, with from two to three times as much for unbalanced valves, while the wear on the link motion varied in about the same proportion.

The expressions in regard to piston valves were all favorable with one exception, this being with a road with five compound locomotives with piston valves.

The different styles of balanced slide valves may be brought down, generally, to two types, viz: Those whose balanced area is enclosed by straight strips, and those who balanced area is enclosed by circles.

It was decided that the Richardson and the American valves could well be taken to represent the two types. One single-balance and one double-balance American valve were tested at Purdue University, and one Richardson valve—the strips were afterward removed from this, the hole in crown plugged, and it was then used as a plain unbalanced valve.

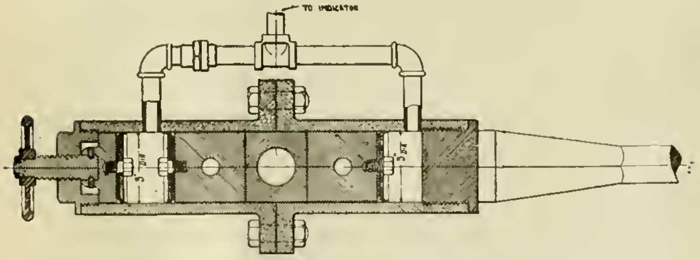


Plate 1.—Section Through Dynamometer.

To get comparative results, the valve seat on the cylinder was filled and scraped to a true surface before the commencement of the test, and the different valves were put in the engine and worn down to a bearing. All tests were made on the right side of the locomotive, and in the forward motion only. The valves used were all new.

In order to measure and record the force necessary to move the valves a dynamometer (see Plate 1) was connected by a hinged pipe with an ordinary indicator, the motion of the drum being taken from the valve stem. While this dynamometer was rather a crude affair and not one that the Committee would recommend for accurate work, on account of the variable friction of the leathers and the method of taking up the water used by the indicator, yet it was the best that the Committee could obtain, and every effort was made to secure results that could at least be comparable. The dynamometer and the indicator gave one inch height on the diagrams for 800 pounds on the valve stem. Steam chest and cylinder diagrams were taken simultaneously and a large and regular flow of oil from the lubricator was maintained. In the friction tests about 150 miles were run and over 600 cards taken in this and the Allen port experiments.

It was decided to work in the first, eighth, eleventh, thirteenth and fourteenth notches, and at speeds of 10, 20 and 40 miles per hour, and as these notches gave cut-offs of 21¾, 18¼, 14¼, 9¼ and 6½ inches respectively, it was believed that the range was sufficient.

In order to explain the different curves of the friction diagrams obtained the unbalanced diagram at first notch and 20 miles per hour, is reproduced on Plate 2, as a representive type of the set. The difference in height between the forward and backward strokes is due to the steam pressure on the area of the valve stem, which resists forward motion, and assists backward. This is shown by the shaded area (see Fig. 1).

The lines $a-b$ and $c-d$ (Fig. 2, Plate 2) show the load resulting from the inertia of the parts. As far as the friction of the valve is concerned, there must also be a correction for inertia. In order to show the valve friction, free from the effects of inertia and the area of valve stem, Fig. 3, Plate 2 has been constructed, correction having been made for both of these points. This enables one to analyze the valve friction at various points of the travel, by placing under the diagrams a section of valve and seat, and moving the valve to the various positions. This curve (Fig. 3) is for the backward stroke only, and the analysis appears in Fig. 4, reference being made to several letters.

A corresponds to the extreme front end of travel, and at *B* the full pressure is registered on the indicator at the end of the pipe, and the curve falls from the friction of rest to the friction of motion. From *C* to *D* the valve becomes partly balanced by the portion overhanging steam port *N*, and reduces the friction. From *D* to *E* port *N* closes, the steam expands, reducing the balance, and the friction rises slightly. From *E* to *F* the steam in port *N* expands more, slightly increasing the friction. From *F* to *G* compression begins in port *M*, increasing the balance and diminishing the friction slightly. From *G* to *H* the steam in port *N* is exhausted, diminishing the balance and increasing the friction. From *H* to *I* the admission of steam in port *M* increases the balance and the friction drops, and from *I* to *J* the valve moves from off port *M* and the friction increases. From *J* to *K*, the end of travel, the conditions remain nearly constant.

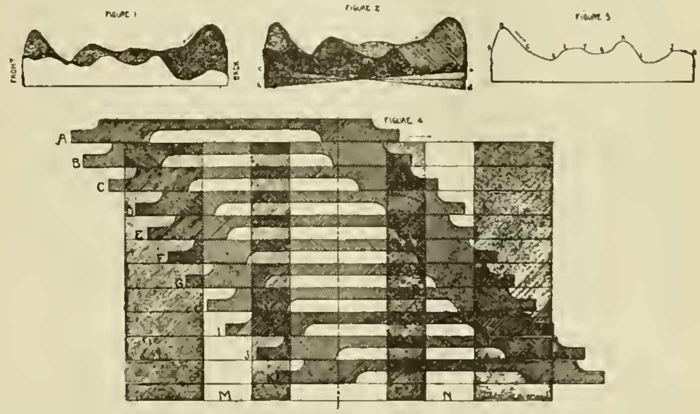


Plate 2.—Diagrams from Dynamometer.

It would require too much time and space to thus analyze all the diagrams, but those who wish to study the effects closely can proceed as indicated above.

The committee found it was unable to determine the stuffing-box friction, but this would probably be constant. It is found that the unbalanced valve requires twice as much work to move it as the balanced valves, and your committee believes that this will represent the average results in ordinary railroad practice. Of course, by balancing a large area, the friction could be still further reduced, but the danger of the valves lifting off its seat would be rather great. Your committee, therefore, recommends the following rule for balancing slide valves:

Area of balance = area of exhaust port + area of two bridges + area of one steam port.

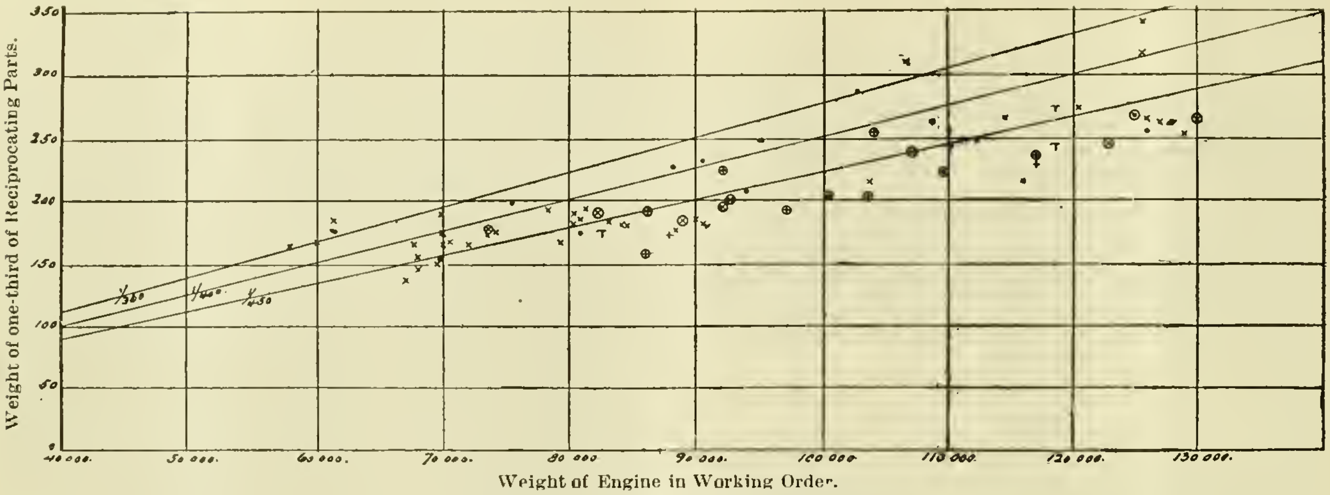
The above is to obtain for both Allen and plain valves.

Your committee had hoped to be able to give the results of some experiments with a piston valve on a simple locomotive but were not able to do so.

ALLEN VALVES.

The responses to the circular developed the fact that of 10,934 engines on 50 roads, 513 were equipped with the Allen ported valve. Incidentally, it may be mentioned that all but one were balanced. The great majority are used in passenger service only, though several advised that they made no distinction in the use of this type of valve. It also appeared that in some cases an engine with an Allen valve was given one or two more cars than an engine with a plain valve, and also that less lead was used. While the majority of replies showed that the Allen valve was satisfactory and especially advantageous at light speeds and early cut-offs, yet a few condemned the valve as having no advantage over the plain type. Some have substituted long ports in place of the Allen valve, one case of which your committee knows, having used ports 23 inches long on a 19 × 24-inch cylinder. This was to obviate the breaking and imperfect coring of the Allen valve.

In order to obtain strictly comparable indicator cards, a false seat was prepared to take an Allen valve with the same elements and motion as the plain valve. The runs were made in the 1st, 8th, 11th, 13th, 14th and 15th notches, and at speeds of 10, 20, 30, 40, 50 and 60 miles per hour, as far as it was possible to obtain them. As might have been expected, the indicator cards show that the mean effective pressure with the Allen port is greater than without it at the ordinary running positions. The average shows 20 per cent. in favor of this valve. Of course it must not be concluded that this 20 per cent. will be gained without an increase in fuel, for from the nature of the argument it has been shown that more steam is admitted to the cylinders, and hence more fuel is necessary, but it can be considered that the Allen port has enabled the piston to exert 20 per cent. more useful pressure on the crosshead for each stroke. It is



Locomotive Counter-Balancing.—Fig. 1.

also readily apparent that the earlier the cut-off the more is gained by the Allen valve. This is also true in a measure of the increase of speed, although it is not so marked as in the case of the ratios of expansion. It is also clearly demonstrated that a better steam line can be obtained. Long ports, or increased travel, may give us good results by the indicator, but here again come the increased weight and area of valve, or the greater speed and longer stroke, both of which mean increased power absorbed in moving the valve with corresponding wear on seat and link motion. This Allen valve weighed 125 pounds, against 85½ pounds for the plain valve, and the total area was only 190 square inches, against 161½ square inches for the plain valve, and in the case of an engine already built, both of the other methods seem impractical, whereas the Allen valve is easily applied.

Your committee, therefore, believes that this 20 per cent. increase in piston power, due to the Allen valve, can often be realized in practice, and that it must certainly mean greater power developed by the engine, though not necessarily greater power per unit of fuel consumed.

CONCLUSION.

In concluding this paper your committee desire to thank the Purdue University and Professor Goss in particular for the use of the laboratory and services of their assistants, without which it would have been difficult to proceed with the work. Mr. Wilson, of the American Balance Slide Valve Company, also deserves the thanks of the committee for furnishing two valves and steam-chest covers and valuable assistance at the tests, and the same remarks apply to Mr. Hammett, who furnished two Richardson valves and the false seat, as well as doing much hard work with the committee at Purdue. They also wish to express the indebtedness due the Schenectady Locomotive Works for the new steam chest and studs, the Lehigh Valley Railroad for furnishing the dynamometer, and the Norfolk & Western Railroad for the various yokes and rods, and the use of the valve motion indicator.

Counter-Balancing Locomotives.

E. M. Herr, W. H. Lewis, C. H. Quereau, S. P. Bush, Committee.

Your committee have formulated the rules which follow, after full consideration of the following fundament principles:

First. The weight of the reciprocating parts that are left unbalanced should be as great as possible, consistent with a good riding and smooth-working engine.

Second. The unbalanced weight of the reciprocating parts of all engines for similar service should be proportional to the total weight of the engine in working order.

Third. Total pressure of the wheel upon the rail at maximum speed when counter-balance is down must not exceed an amount depending upon the construction of bridges, weight of rail, etc., and when counter balance is up the centrifugal force must never be sufficient to lift the wheel from the rail.

A majority of railroads answering the committee's circular leave unbalanced one-third of the reciprocating parts. In order to see how nearly this method makes the unbalanced weight of the reciprocating parts proportional to the total weight of the engine, we have plotted on Fig. 1 the relation of the unbalanced reciprocating weight on one side and the total weight of 75 road engines in acual satisfactory service on seven different roads. On the same diagram are drawn lines, all the points in which are proportional to the total engine weights laid off on the horizontal. The first line marked $\frac{1}{450}$ is drawn through about the average of all the points plotted, and indicates that the average unbalanced weight of the reciprocating parts on one side of engine as balanced on these roads is $\frac{1}{450}$ of their total weight. The upper line marked $\frac{1}{360}$ represents the ratio of unbalanced reciprocating parts on one side to the total engine weight, recommended by Mr. G. R. Henderson, Mechanical Engineer of the Norfolk & Western Railroad, in an admirable report on this subject made to Mr. R. H. Soule, about a year ago and to which your committee is indebted for valuable data and suggestions. Mr. Henderson proposes the following formula for expressing the relation between the unbalanced reciprocating parts and the total weight of the engine:

$$Wr = \frac{Wt}{360}$$

Wr = the weight of the unbalanced reciprocating parts on one side.

Wt = the total weight of the locomotive in working order.

From the data obtainable, we believe this formula allows a greater proportion of the reciprocating parts to remain unbalanced than present good practice will warrant.

The intermediate line marked $\frac{1}{400}$ on diagram indicates the average maximum of unbalanced weight of reciprocating parts in locomotives now in service on various roads. From actual tests of locomotives so balanced in fast passenger service, we recommend it as a safe formula for the maximum limit of the weight of the unbalanced proportion of the reciprocating parts on one side.

In formulating the following rules it is assumed that the driving wheels are finished and mounted on their axles with pins in place.

In designing new locomotives the proper counter balance weight should be calculated and cast into the wheel centers as follows: Place the center of gravity of counter-weight opposite the crank-pin as far from the wheel center as possible and have it come as near the plane in which the rods move as proper clearance will allow. To obtain weight of the reciprocating parts and detachable revolving parts, proceed as follows:

RECIPROCATING PARTS.

Take the sum of the weights of piston complete, with packing ring, piston rod, crosshead complete, and the weight of the front end of the main rod complete. Weigh each end of rod separately supported.

REVOLVING PARTS.

Weigh the back end of the main or connecting rod, and each end of each side rod complete, separately supported. The sum of the weights so found which are attached to each crank pin are the revolving weights for that pin.

RULES FOR COUNTER-BALANCING LOCOMOTIVE DRIVING WHEELS.

First. Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side as found above, including the front end of the main rod.

Second. Distribute the remainder equally among all driving wheels, adding to it the weight of the revolving parts for each wheel. The sum will be the counter-balance required if placed at a distance from the wheel center equal to the length of the crank.

SHOP METHOD OF COUNTER-BALANCING MOUNTED LOCOMOTIVE DRIVING WHEELS.

Place the axle with journals upon the straight edges and level the straight edges by means of the adjustment screws. Turn the wheels until the center of one crank pin is above and exactly in a vertical line drawn through the center of the axle. Hang a yoke on the opposite pin; then add weights until the sum of the weight of the yoke and weights equals the exact weight of all the detached revolving parts on this wheel, plus the proportion of the reciprocating weights determined by rules given above. Increase or decrease the counter-balance opposite the crank pin until it exactly balances the weight thus applied. Repeat this process for the opposite wheel in the same manner.

Counter-balance weights added to old wheels should be generally cast in two parts, fitted between spokes, securely bolted, with the ends of bolts riveted over the nuts. Increased weight of counter-balance can be obtained when necessary by boring out cast iron and substituting lead, or in other ways replacing cast iron with a denser material.

CAUTIONS AND LIMITATIONS.

If we assume that the maximum speed in miles per hour of the driving wheel of a locomotive equals its diameter in inches, it can easily be shown (see appendix) that if such wheel is overbalanced by an amount W, at its maximum speed, this overbalance will increase and decrease the wheel pressure on the rail each revolution 38.4 times W, or denote such increased pressure by P, then P = 38.4 times W, or nearly $P = 40\ W$. Therefore, in order that the wheel shall never leave the rail, 40 times the portion of the weight of the reciprocating parts added to each wheel must not exceed its static pressure on the rail. To insure safety it should not exceed 75 per cent. of such pressure. Nor should this amount, when added to the static wheel pressure, exceed the safe maximum pressure allowed on track and bridges. Locomotives with rods disconnected and removed should not be hauled at high rates of speed.

Make reciprocating parts as light as possible.

Spread cylinders as little as possible.

The committee recommends that a number of roads be selected to try the rules outlined, and report result of the trial before the convention of 1897; and that the committee be continued until that time, when, if the practice is found satisfactory, it can be adopted as standard.

APPENDIX.

We take the following from Mr. Henderson's report:

"To determine the centrifugal force, we have from Weisbach, Vol I., page 609, the following formula:

$P = .00034\ U^2 G\ R$

U = revolutions per minute.
G = weight in lbs.,
R = radius in feet. Now let
s = speed in miles per hour;
d = diameter of wheel in inches, then

$$U = \frac{s \times 5280 \times 12}{3.1416 \times d \times 60} = \frac{s \times 1056}{d \times 3.1416} = 336\frac{s}{d}$$

and

$$U^2 = 112896\frac{s^2}{d^2} \text{ and, substituting, we have,}$$

$$P = 38.4\frac{s^2}{d^2} G\ R \qquad \text{and where } R = 1,$$

$$P = 38.4\frac{s^2}{d^2} G$$

If we assume that the speed in miles per hour at its maximum equals the diameter of the wheel in inches, we have simply

$P = 38.4\ G$, or say, $P = 40$ G.

Steps and Handholds.

John Medway, H. Bartlett, J. T. Gordon, F. M. Twombly, G. H. Baker, Committee.

The majority of those answering the circulars of the committee are in favor of a wide double step on the front corners of the tender frame and long vertical grab irons, or handholds, on the front corners of tanks, on the back of cabs and in connection with the cab brackets. A few persons favor a wide step on the back corners of engines also. The form of steps used extensively on modern locomotives usually contains too deep an opening in the riser. This feature the committee considers an element of danger in that the foot is liable to slip through. They recommend that the distance between the tread and opening be not less than five inches. The step recommended by them is shown in Fig. 1. They do not advocate steps at the back corners of tenders. For switching-engines they recommend long steps suspended transversely from the back of the tender frame. The step should have a back guard to prevent the foot from slipping through. It should be made and applied in a substantial manner and set at the uniform height of 12 inches from the rail. Care should be taken to leave an opening between the tread and riser sufficient to dispose of ice and snow, but not large enough to admit a part of the foot. In connection with this

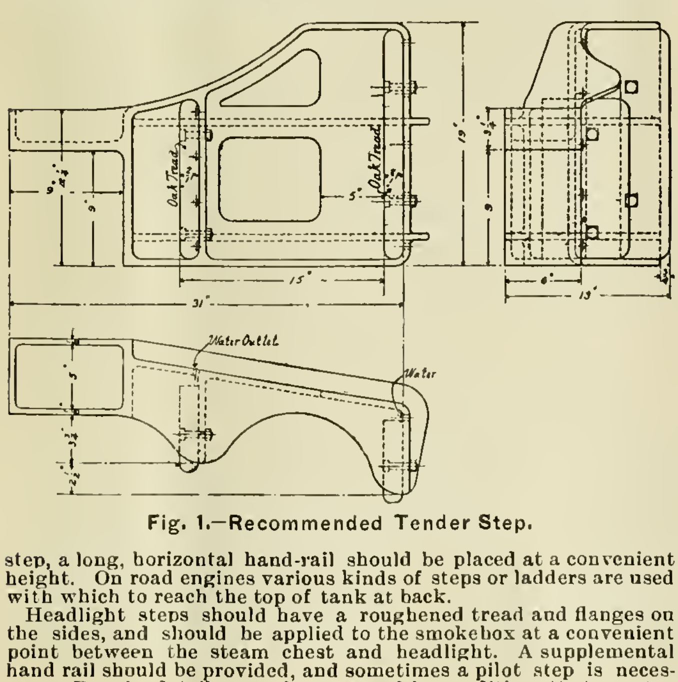


Fig. 1.—Recommended Tender Step.

step, a long, horizontal hand-rail should be placed at a convenient height. On road engines various kinds of steps or ladders are used with which to reach the top of tank at back.

Headlight steps should have a roughened tread and flanges on the sides, and should be applied to the smokebox at a convenient point between the steam chest and headlight. A supplemental hand rail should be provided, and sometimes a pilot step is necessary. But the details must be governed by conditions that vary too much to permit of a general rule. To reach sand boxes, steps similar to those on the smokebox are satisfactory.

In conclusion, the committee is of the opinion that to insure comparative safety the form and location of locomotive steps and handholds should be so nearly uniform that in mounting or alighting one could, even in the dark, readily locate with his feet and hands all the steps and handholds of any locomotive.

Cylinder Bushings.

J. N. Barr, J. H. McConnell, J. S. Chambers, Geo. F. Wilson, W. H. Marshall, Committee.

The conclusions of this committee are summarized as follows:

First. That cylinder bushings ½ inch to ¾ inch in thickness will meet all requirements.

Second. The bushings should be turned to the same diameter as the cylinder fit.

Third. Bushings of a uniform outside diameter and extending from the back to the front cylinder head, or bushings extending from the back steam port to the front head, the bearing surface of the cylinder heads resting partly on the end of the bushing and partly on the cylinder proper, without any fastening except the pressure of the heads, will give perfectly satisfactory results.

Fourth. The use of bushings is a practical method of reducing the bore of cylinders, of repairing cracked and worn cylinders, and avoiding the difficulty of cylinders which are too soft.

Fifth. The question of fuel and oil economy, which may be obtained by the use of hard, homogeneous bushings, is one which should receive careful attention.

Those recommending the use of bushings for new cylinders do so on the following considerations: The qualities required in a cylinder casting in order to withstand the strains to which it is subjected are especially strength and toughness. These two qualities are, however, inconsistent with the hardness that is necessary to secure a good, smooth polish in the bore of the cylinder. In the attempt to obtain a good wearing surface in the cylinder, the casting has a tendency to become of such a character as is liable to crack in service.

By the use of an independent bushing a perfectly clean casting of uniform density throughout, and of such a hardness as will give the best results as to wear can be obtained without in any manner influencing the quality of the material in the body of the cylinder.

It should be borne in mind that frictional resistence between the cylinder and the piston consumes a large amount of power, and any means which will reduce this resistance is likely to produce a freer working engine, and one more economical in consumption of fuel and oil.

Some members of your committee are decidedly of the opinion that the advantages gained by using a brushing harder than it is possible to obtain in the ordinary cylinder casting effect a decided economy in the above respects.

In this connection your committee desire to call attention also to the matter of false valve seats. If these are cast separately, they can be made much harder than the ordinary solid seat. The false seats are now constructed in such a way as to give practically no trouble, and with the adoption of the false valve seats, and a cylinder bushing of the proper hardness, the entire wearing parts of the cylinder would be fully provided for, and the failure of the cylinder would simply depend on its power of resisting the strains to which the body is subjected in service.

Standard Size of Boiler Tubes.

Wm. Swanston, Committee.

The committee recommends that the standard specifications for locomotives iron boiler tubes be changed to conform to the decimal gage of the association and to allow additional thickness at the weld by being made to read as follows: Under the head "Dimensions and Weight."

TUBES 2 INCHES OUTSIDE DIAMETER.

.095	inches thick and weight at least	1.01	pounds per foot.
.110	" " "	2.19	" "
.125	" " "	2.47	" "
.135	" " "	2.65	" "

TUBES 2¼ INCHES OUTSIDE DIAMETER.

.095	" " "	2.16	" "
.110	" " "	2.48	" "
.125	" " "	2.80	" "
.135	" " "	3.01	" "

Under the heading of "Surface and Inspection," "and must be of uniform thickness throughout, except at the weld, where one gage number additional thickness will be allowed" be changed to read "where .015 inches additional thickness will be allowed."

The committee urges strongly the importance of using the decimal gage in ordering all kinds of material for which it was designed and adopted by the association.

Driving Box Wedges.

J. Davis Barnett, H. A. Childs, T. J. Hatswell, R. Atkinson, R. E. Reading, Committee.

The replies to the circular of inquiry issued by this committee only numbered 49, but of those answering, a decided majority are in favor of wedges that cannot be adjusted on the road. The data presented to the committee by members was unsatisfactory and the committee says that the strongest point the replies justify them in making is that those who dispense with movable wedges do not go back to them.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS AND SUMMARIES OF REPORTS PRESENTED AT THE THIRTIETH ANNUAL CONVENTION.

Axle, Journal Box, Bearing and Wedge for Cars of 80,000 Pounds Capacity.

E. D. Nelson, J. H. Rankin, George Gibbs, William Forsyth, John Hodge, J. E. Simons, F. W. Chaffee, Committee.

The larger part of the report has been devoted necessarily to the axle, not only because it was essential first to decide upon its design before the journal box, wedge and brass could be considered, but because it was realized that there were two limits between which it was necessary that the design should fall. The first of these was that the limit for strength should, unquestionably, leave no doubt as to the *safety* of the design. The breaking of a car axle is becoming daily a more serious matter. On double track roads it involves not only the safety of the train in which it may fail, but of both passenger and freight trains on the opposite track. Evidence of the seriousness of this matter is only too easily obtained. The other limit was that of cost. To meet these ends has been the aim of your committee.

The plan of the report is to discuss first theoretically the matter of strains in the axle, in which is included from practical information the important element of vertical oscillation on the springs. The question of fiber stress is then considered, and following this is a discussion of the journal proportions from the standpoint of friction and lubrication. Conclusions having been reached under these heads the design of the axle naturally follows, with specifications for the material to be used. Reference to the designs for journal box, wedge and bearing will be found in the concluding paragraphs.

Next follows a complete analysis and calculation of the strains in an axle resulting from all the forces acting on it, Reuleaux's method being employed. These calculations are compared with a second set computed by the method of Wohler, which is based largely on experimental data obtained with four-wheeled cars on Prussian railways. We have not the space to devote to these excellent mathematical demonstrations, but must refer our readers to the report itself. One interesting experiment in this connection, however, we record. To apply the calculations to practice, it was necessary to know how much the static load on the axle was increased by the vertical oscillations of the car on its springs. Wohler states, from his experiments with four-wheel cars on the Prussian State railways, that the weight on the journal is increased three-eighths by the force due to vertical oscillation. As this was determined by experiments in four-wheel cars and on railroads in Prussia the committee endeavored to confirm this figure by experiments on American railways and with eight-wheel cars.

The method employed was as follows: A car fitted with Fox trucks was selected, the box springs taken out, and each spring was carefully calibrated, to show the force necessary to compress it each one-eighth of an inch from the height of spring free to the spring when down solid. Each spring was then fitted with a simple recording apparatus, shown in Fig. 1, intended to register the maximum compression of the spring in inches, and the springs were replaced in the trucks.

A piece of ¾-inch gas pipe *C* was finished outside and slotted longitudinally at *B* and fitted in the hole *A* drilled through center of spring cap, and having sufficient friction so as not to be moved by any jolting of the truck.

Any compression of the spring caused the pipe *C* in contact with the boss *D* on the journal box to be forced upward into the hole *A*, where it would remain, thus registering the compression of the spring.

The car was a box car of 60,000 pounds capacity and was loaded to 67,800 pounds; the light weight was 34,400 pounds; the total being 102,200 pounds; the total weight of wheels, axles, boxes, brasses, etc., was 7,848 pounds; this deducted from 102,200 pounds leaves 94,352 pounds as the weight above the springs, which divided by 4 gives 23,588 pounds as the weight on each axle above the springs, or 11,794 pounds on each spring, due to the static load.

The car was then run from Renovo, Pennsylvania, to Canandaigua, New York, over the lines of the Pennsylvania Railroad, and back to the starting point, a distance of 398 miles. The springs were then removed and again calibrated, in order to check the former figures found, made before the car was started. The springs were also measured at the Altoona physical testing laboratory, to confirm the measurements made with the shop apparatus employed. The maximum compression of each spring was found from the recording apparatus, which was placed over each box.

The average maximum compression of the eight springs was found to be equal to a load of 19,469 pounds on each spring. The maximum compression for any one spring was found to be 23,403 pounds. From these figures it is proposed to deduce the value of the force due to vertical oscillation of the car on the springs.

If the maximum horizontal force acting on the car be taken as 40 per cent. of the static load and the center of gravity of the loaded car be 72 inches above the rail, calculation shows that in the case of the car tested the maximum load on one journal was 18,573 pounds, without considering the effect of vertical oscillation on the springs.

It can be proved that if the center of gravity of the car is 72 inches above the rail, that 40 per cent. of the static load acting horizontally will almost entirely relieve the weight on one rail. In other words, the assumed value of the horizontal force is very nearly sufficient to turn the car over. Hence we may consider the

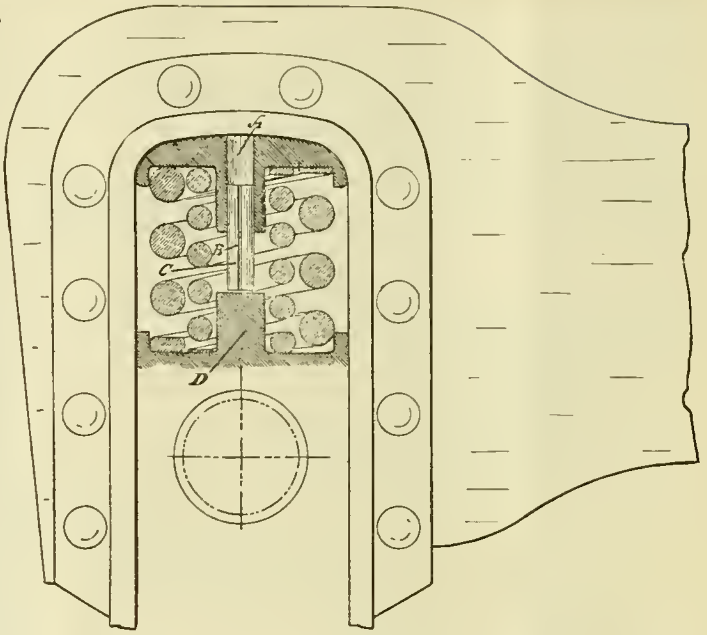


Fig. 1.- Apparatus for Determining Vertical Oscillation of a Car on Its Springs.

assumed value as a maximum, and with this assumption our calculation gives 18,573 pounds as the maximum compression on one spring due to that force and the static load. But the maximum compression on one spring by experiment was 23,403 pounds, and consequently the difference between these two amounts may be regarded as due to vertical oscillation of the car on the springs. This is not necessarily the actual vertical oscillation, but it may be considered as the maximum vertical oscillation when the horizontal force is taken as a maximum. This difference is 4,830 pounds. This is equal to 41 per cent., nearly, of the static load on each journal, which was 11,794 pounds. As formerly stated, Wohler found by experiment that the force due to vertical oscillation was ⅜ or 37.5 per cent. of the static load on each journal, so that the amount as found in the experiment made by the committee agrees closely with his results.

The formula for the moment of the forces at the hub and at the center when the axle is mounted on 33-inch wheels is by Reuleaux's method found to be as follows:

$$M = \frac{W b}{2} - \frac{H h}{m}(x - b) + \frac{H h_1 x}{l} + H h_2 + \left(\frac{W}{2} - \frac{H h_1}{m}\right) h_2 \tan a \qquad (1)$$

where

W = the total vertical pressure on the axle, including allowance for vertical oscillation.
H = horizontal force caused by curves, switches and wind pressure.
h = height of center of gravity of car above top of rails.
h_1 = height of center of gravity of car above center of axle.
h_2 = height of center of axle above top of rails.
l = length of axle between points of application of total load W.
m = distance between center of rails.
b = the distance from center of rail to point where load on journal is assumed to act.
x = any distance along axle from point where load on journal is assumed to act.
a = angle between head of wheel and the horizontal.

According to Wohler's method the formulas are as follows:

For the hub

$$M = .176\, W b + .516\, W + 322.245 \sqrt{W} + 4.125\, H$$

and for the center

$$M = .176\, W b + .516\, W + \tfrac{1}{2}(322.245 \sqrt{W} + 4.125\, H)$$

where M = the moment of the forces,
W = the total weight above the springs,
H = the horizontal forces.
b = distance from center of rail to point where journal load is concentrated.

The diameters at the hub and at the center may be calculated by the well known formula

$$d = \sqrt[3]{\frac{M}{.0982 f}}$$

where M = the moment of the force,
f = the fiber stress.
d = the diameter of the axle.

These formulas suffice to determine the dimensions between the wheels when the maximum allowable fiber stresses are decided upon.

The committee have in these general formulas taken into consideration all the forces acting upon that portion of the axle lying between the wheels, except the force due to impact or percussion. This latter is confined entirely to the journal and that portion of the axle lying outside of the wheel, and is not communicated to that part of the axle lying between the wheels, because in order to have any force applied at the journal produce a bending of that portion of the axle lying between the wheels it is necessary that the part of the wheels in contact with the rails should move toward each other, and that the tops of the wheels should at the same time move away from each other. The resistance to this movement would be the inertia of the mass of the wheels themselves, and also the friction of the wheels when sliding inwardly on the rails if such movement took place. The force of impact would not take place over a sufficiently long interval to allow any effect upon the axle between the wheels. Wohler states that the portion of the axle lying outside of the wheels can only be determined from practical considerations.

We have determined how the diameter at the center of the axle and at the hub may be found. Now if we consider the weight acting at a point in the journal, the form of the axle from that point to the wheel fit, in order to have it of uniform strength, would be a parabola. This is within the demensions necessitated by running the wheel fit out cylindrically and providing proper diameters for the dust-guard seat and journal. Hence the margin of strength in the journal and dust-guard seat is much above that taken for the hub and center.

FIBER STRESS.

Under this head the committee first takes up the natural limits of elasticity. When testing was first employed to determine the nature of a material, it was quickly noticed that when the specimen was loaded or bent beyond a certain point it would not recover its original dimensions or shape upon the removal of the load. The limiting stress or straining, below which no permanent effect upon the specimen could be noticed, was called the "elastic limit." It appeared obvious to experimenters that since the specimen recovered completely its original form and dimensions, it had not been injured, and it would be safe to apply any loads within the elastic limit indefinitely without any injury resulting.

Subsequent practical experience, however, proved that under the conditions of repeated reversals of stress it is not safe to subject a bar to a strain anywhere near the elastic limit, *as determined in the testing machine.*

According to Wohler, who spent some 12 years at the instance of the Prussian Government in experimenting upon the effect of repeated stresses in small bars, the outer fiber stresses, where the strains alternated between tension and compression, he found might be safely taken as 17,000 pounds per square inch for iron and 23,000 pounds per square inch for steel, without limiting the life of the bar, but if the stresses exceed these limits, fracture would always occur if the number of repetitions of stress were sufficient. This is a stress of approximately ⅓ the tensile strength of the material, and is considerably within the elastic limit as ordinarily determined.

In large bars, such as car axles, where the extreme or outer fibers are a considerable distance from the neutral axis, and where the material is often far from homogeneous throughout, it is reasonable to suppose that strains are not transmitted symmetrically in all its parts and some of the fibers may bear a larger proportion of the total stress than would occur in even distribution. In this way the elastic limit may be locally exceeded with a very moderate total stress only.

From all evidence it seems reasonable to conclude that a material will not be injured if strained repeatedly any amount within its natural elastic limit; that the so-called "fatigue of metals" may be noticed if strains are in excess of this natural elastic limit, and still within the elastic limit as ordinarily determined; that there is a possibility of the natural elastic limit being exceeded at points locally within the structure of a large mass by a moderate total strain, thus starting local cracks which will extend to the ultimate destruction of the piece.

As to the effect of temperature, it seems to be pretty well established that the effect of ordinary atmospheric changes of temperature, say, from 20 degrees below to 120 degrees above zero Fahrenheit, upon the physical properties of iron and steel, are slight and unimportant when stresses are applied without shock. But the effect of a change of temperature upon the ability of these metals to resist shocks is not so definitely known.

Mr. Thomas Andrews, in a paper read before the Institution of Civil Engineers, 1887, gave results of tests by impact under a drop hammer, of forty-two full-size iron axles, the axles having been heated and cooled to various degrees, for the purpose of determining the effect of temperature upon strength.

He found that at 100 Fahrenheit the axles were 43 per cent. stronger than at 7 degrees, and concludes that low temperature materially reduces the power of resistance of railway axles to continued heavy impact.

It is to be doubted, however, whether these tests throw much light upon the effect of temperature upon axles as stressed in service, since the shocks in his method of tests were altogether more severe than those met with in service, from six to eight blows being sufficient in each case to break the axle. In fact, experience in this country shows that few, if any, more axles are broken in cold weather than in warm, and it is reasonable to assume that the greater rigidity of the road-bed in winter would fully account for any greater percentage of breakage in that season than in summer. Carefully kept records of axles broken or bent on one of the largest railway systems in this country show that no larger number of axles failed in the colder months than in the warmer ones.

Your committee would consequently offer the opinion that temperature need not be taken into account in determining the design of axle; but that with more definite information it may be advisable that certain limit for variation of temperature should be established as standards for use in testing axles under the drop.

It has been stated that Wöhler found that for an unlimited number of reversals of strain, the fiber stress may safely be taken at 17,000 pounds per square inch for iron and 23,000 pounds per square inch for steel. But as his experiments were made with small specimens, and as axles are subject to various stresses, apparently not included in his investigations, it would seem best to look into the fiber stress of axles in service and see what can be learned. The method of Reuleaux, already given, can readily be utilized to determine the fiber stress of any given axle. It is only necessary to find the moments and from the actual diameters find the fiber stress.

Your committee has followed this method for axles already in use, where they have been in service a number of years, and where the number of axles has been sufficient to justify safe conclusions by such an analysis.

Taking the fiber stress calculated in this way it was found that a large number of axles had broken of one design where the fiber stress was 28,000 pounds, these axles having been in service from four to nine years. Where the fiber stress was 23,000 pounds and less, the records show that axles have been practically free from failure by breaking.

The fiber stress of 28,000 pounds was found approximately the same at the wheel seat and center, and the records showed that breakage took place at both of these points.

Furthermore, the axles with the lower fiber stresses, and which have not broken, show that for the strains found by Reuleaux's method the fiber stress is approximately uniform between the wheels.

Your committee has concluded, therefore, that if the new axle is designed, using the strains as found by Reuleaux's method, and if a fiber stress of 22,000 pounds per square inch is taken for the portion of the axle between the wheels, and the material provided in the specifications is used, a safe design will be the result without much surplus material.

Concerning the fiber stress in journals, this portion of the axle is subjected to strains of a more complicated nature, and the results of experience will be the safest guide.

From an examination of the fiber stress in journals which have broken and which have not broken, it is concluded that, for the diameter attained when the journal is worn to its limit, the fiber stress for static load should not exceed 11,500 pounds per square inch. It would be safer to keep it close to 10,000 pounds per square inch, which figure has been adopted for the diameter when it has reached the limit of wear.

From the diagram, Fig. 2, the fiber stress in a 5 by 9-inch and 4¼ by 8-inch journal when new, worn, and worn to limit, can be found for any load from 9 000 pounds to 35,000 pounds. The load W is applied at a distance J from the shoulder of dust-guard seat. The value of J is 5⅞ inches for a 5 by 9-inch journal, and 5⅛ inches for a 4¼ by 8-inch journal. The lever arm T for moments is shown in each on the diagram and is taken from tangent of circle at fillet to point of concentration of load W.

It will be seen that the stress under a static load of 15,500 pounds, is, for a new axle with a 5 by 9-inch journal, 6,300 pounds, and when worn to limit, 4½ inches in diameter, it is 10,200 pounds. A new axle with 4¼ by 8-inch journal, with a static load of 11,000 pounds, would have a fiber stress of 6,500 pounds when new and 10,800 pounds when worn to the limit of 3¾ inches in diameter.

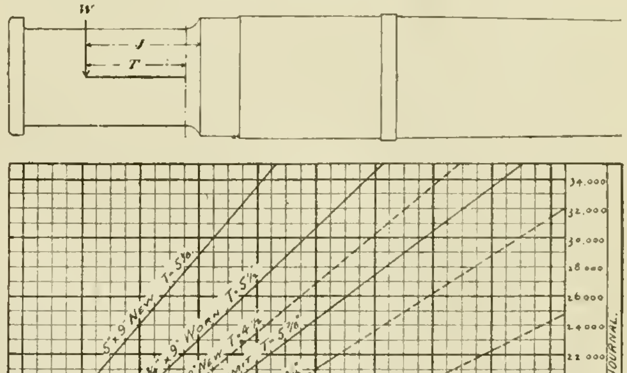


Fig. 2.—Fibre Stresses in 5″ × 9″ and 4¼″ × 8″ Journals.

The stress in the journal due to any assumed maximum load may thus be found direct from the diagram.

THE JOURNAL—FRICTION AND LUBRICATION.

Considering the proportions of the journal with respect to friction and lubrication, the principal figure desired is the maximum pressure per square inch which can be placed on freight car journals without undue friction, wear of bearing and liability to heat.

Laboratory experiments made in this country and Europe do not give any satisfactory data on this subject, and we are compelled to assume that the 4¼ by 8-inch journal is satisfactory for cars of 60,000 pounds capacity, and determine from this the pressure per square inch to be allowed on the new journal. Fig. 3 is a diagram showing the method of determining the area of bearings.

The chord of a new bearing 4¼ inches in diameter is 3.56 inches, and, leaving out fillets, the length is 6⅞ inches, and its area 24.48 square inches. Under a loaded car, allowing 10 per cent. overload,

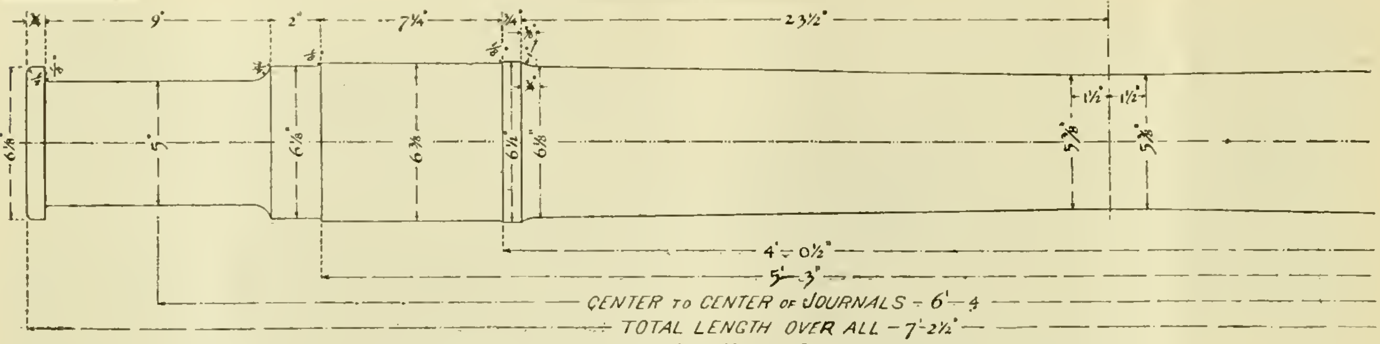


Fig. 4.—Axle to Carry 31,000 Pounds. (For Use Under Cars of 80,000 Pounds Capacity.)

the weight on one journal is 11,000 pounds, and the pressure per square inch is therefore 449 pounds. When the journal is worn down to its limit of 3¾ inches in diameter, the chord is 3 inches, the area is 20.63 square inches, and the pressure per square inch is 533 pounds. If a bearing bored for 4¼-inch journal is placed on a journal worn to 3¾ inches in diameter, the chord of the arcs in contact is less than 1¼ inches. Taking this figure, 1¼ by 6⅞ inches, we have an area of 8.59 square inches, which must carry its share of the weight, and which under a fully loaded car amounts to 1,280 pounds per square inch.

The fact that bearings run some time before they increase the bearing surface to double the amount assumed leads us to believe that it would be safe to proportion a car journal for a load of 600 pounds per square inch.

Professor Denton's experiments on car journals, under very heavy pressures, showed that they might be run under a pressure of 5,000 pounds per square inch, and that the rapid wear would soon increase the area of bearing, and with a pressure of 1,000 pounds per square inch on a polished journal a coefficient as low as 0.11 per cent. has been obtained.

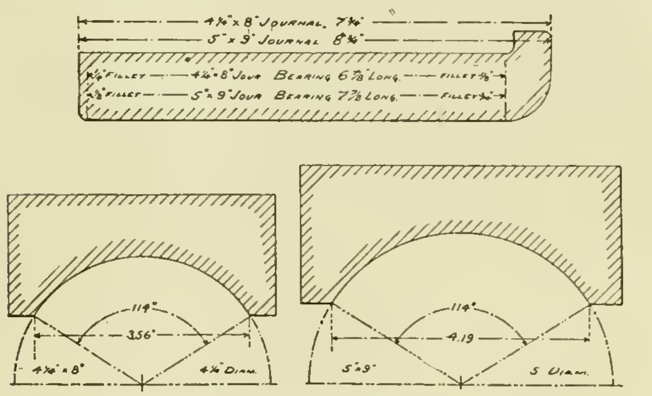


Fig. 3.—Showing Journal Bearing Areas.

For the axle designed to carry 31,000-pound stresses under the maximum load, as has already been seen, would require the journal to be at least 4½ inches in diameter; adding ½ inch for wear it would be 5 inches in diameter; and if we make its length 9 inches and the bearing ¼ inch less, by leaving out fillets we get the length of effective bearing as 7⅞ inches. Taking the same angle of contact as the 4¼ by 8-inch bearing, the length of chord would be 4.19 inches, and the bearing surface of a new journal would be 33 square inches. Taking 15,500 pounds as the load on journal, we have a pressure of 469 pounds per square inch. When worn to 4½ inches diameter the chord would be 3.75 inches and the area consequently 29.53 square inches. This gives 525 pounds as the pressure per square inch.

In our final calculations we have assumed the probable maximum conditions for concentration of the load on journal, which would be when the collar of the journal is worn to ¼ inch in thickness from contact with the brass and the brass worn off ¾ inch on the end next to the collar of the journal. This occurs when the horizontal force previously explained is at its maximum.

DESIGN OF AXLE—REULEAUX'S METHOD.

Having prepared the general methods to be followed and determined the necessary data, we may take up at once the design of the axle. The committee was instructed to design an axle for an 80,000-pound-capacity car, but concluded that the capacity of the car is not a proper measure of the weight carried by the axle.

We will therefore determine for an 80,000-pound-capacity car what would be the maximum weight on each axle, and it should then be understood that the design of axle submitted in this report is one designed to carry that weight, and not an axle for an 80,000-pound-capacity car, regardless of the weight of the car body and trucks. We may assume for the probable weights of 80,000-pound-capacity cars the following:

Gondola car.

Weight of body and trucks	35,600 pounds.
Lading	80,000 "
Twenty per cent. additional lading	16,000 "
	131,600 pounds.
Deduct weight of wheels and axles	7,600 "
	124,000 pounds.

or 31,000 pounds per axle.

Refrigerator car.

Weight of body and trucks	43,600 "
Lading	80,000 "
Ten per cent. additional lading	8,000 "
	131,600 pounds.
Deduct weight of wheels and axles	7,600 "
	124,000 pounds.

or 31,000 pounds per axle.

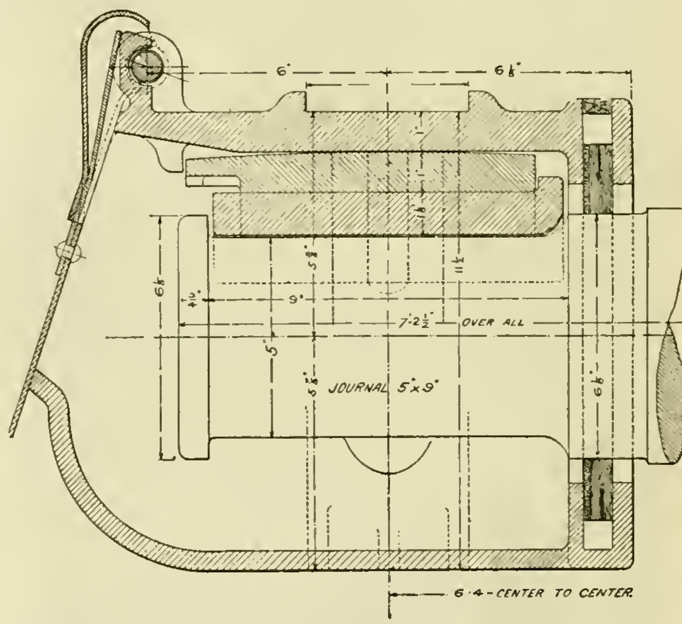


Fig. 5.—Journal Box Complete for 80,000 Lbs. Cars.

NOTE—Distance between bolt centres equals 9 inches.

The axle recommended by your committee is therefore designed to carry 31,000 pounds, including body, trucks and lading. It should be distinctly understood that the axle recommended is to carry this weight, as the sum of the weights of the car body and trucks and lading when using 33-inch wheels.

On the basis of 31,000 pounds static load on the axle and a maximum fibre stress of 22,000 pounds the required diameter of the axle at the hub is found by Reuleaux's method to be 6.21 inches and at the center 5.30 inches; or taking the nearest ⅛ inch for convenience, 6¼ and 5⅜ inches, respectively. To the diameter at the hub it is necessary to add ⅛ inch to provide for reduction of diameter when fitting axles to wheels as allowed in the interchange rules; hence the diameter at the hub becomes 6⅜ inches. Wohler's method would give a less diameter at the hub and greater at the center, but the results of Reuleaux's methods are taken as the better.

DESIGNS FOR AXLE, JOURNAL BOX, WEDGE AND BEARING.

In Fig. 4 is given the design of axle to carry 31,000 lbs.

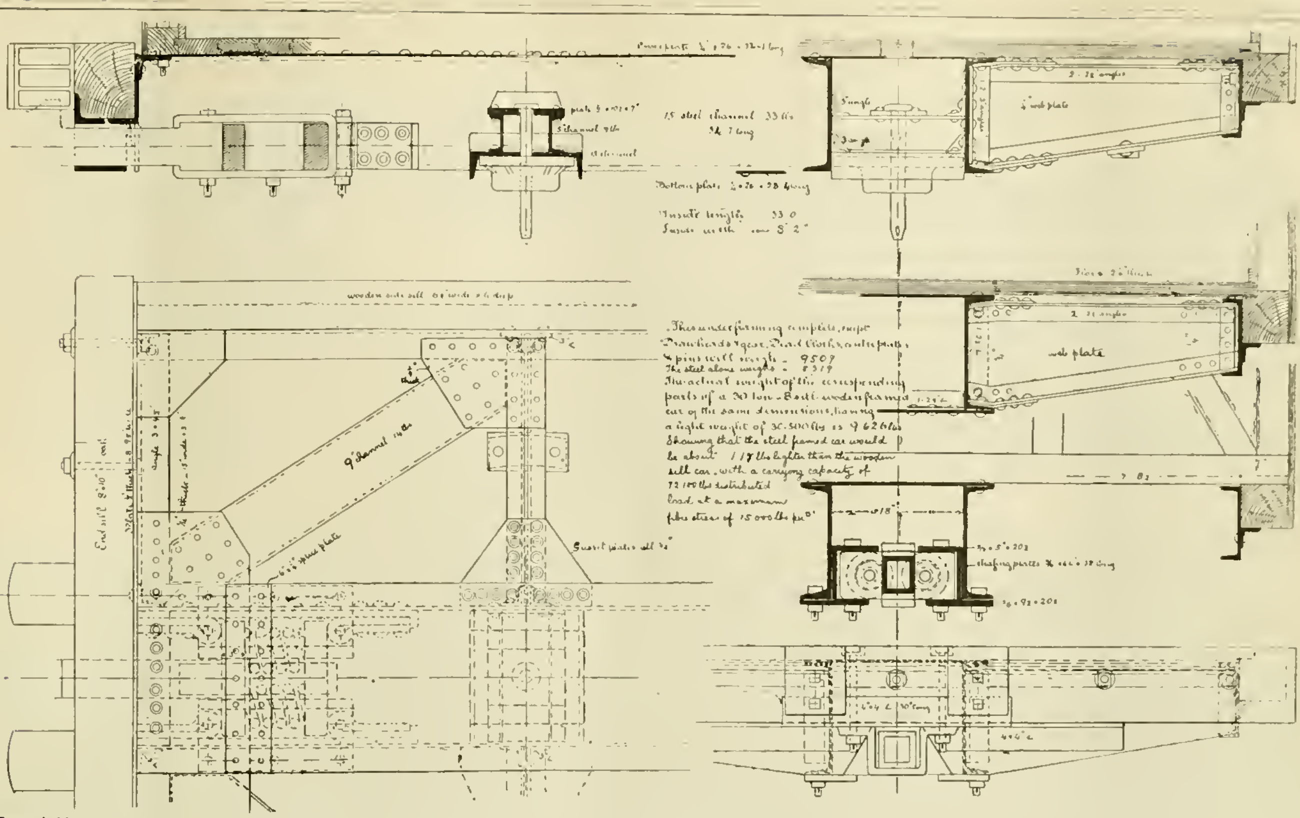
It will be noticed that the axle is cylindrical for a distance of 3 inches at the center, in order to get rid of the angle at the center. The fillet at outer end of journal is made as small as possible without getting a sharp corner, and still making it easy to obtain in ordinary shop practice. The fillet at back end of journal is made large to prevent the rapid wearing to a small fillet at this point.

Fig. 5 shows the journal box and the contained parts in position.

The general design of the M. C. B. journal boxes, already adopted by your Association, has been followed, except that the bottom of the box has been rounded in order to eliminate the corners and to concentrate the oil below the center line of journal, where it has the greatest opportunity to be drawn into the packing.

[Separate drawings of the box, wedge, bearing and lid are shown, but are not reproduced.—ED.]

In another drawing (not reproduced here) is given a portion of the same journal box, except that the face of box has been changed to suit the Fletcher lid. This form of lid has so many advantages that your committee decided to ask consideration of



Steel Underframe for 30-Ton Freight Cars—Designed by R. P. C. Sanderson, Asst. Supt. Motive Power, Norfolk & Western Road, and C. C. Wentworth, Chief Engineer, Virginia Bridge Works.

it as compared with the form of lid already adopted for cars of less capacity.

SPECIFICATIONS.

A set of specifications for iron and another for steel axles accompany the report. They go into minute details and would occupy too much space to be printed here. A summary of the steel-axle specification is as follows: The axle must be free from physical defects that can be detected by the eye. It must be rough-turned all over with a flat-nosed tool, except for a short distance just inside of each wheel fit. The composition of the steel must conform to the following:

Carbon	0.40 per cent.
Manganese, not above	0.50 " "
Silicon	0.05 " "
Phosphorus, not above	0.05 " "
Sulphur, not above	0.04 " "

All axles must be stamped with name of maker and the blow or heat number. Axles from any one heat must be kept together for inspection. At least 30 axles from each heat must pass the physical inspection. Then one axle from each heat passing this inspection will be subjected to physical (drop) test. The drop test must be carried out on a machine with a spring-supported anvil similar to that illustrated in the *American Engineer* for April, 1896. The anvil is to weigh 17,500 pounds; the drop weight, 1,640 pounds. Each axle must stand five blows from a height of 43 feet, without rupture or fracture. A deflection is desired of not more than 5½ inches, after the first blow, and a deflection of more than 6½ inches will cause rejection. Axles will be rejected if the chemical test shows:

Carbon	below 0.35 per cent. or above 0.50 per cent.
Manganese	" 0.60 " "
Phosphorus	" 0.07 " "

The specifications for iron axles call for double-worked fagoted scrap, into the center of which 80 pounds of new bar iron can be worked if desired. They must not show any seams having a clear opening of 1/32 inch or more, and being more than 1 inch long. From each 101 axles, one will be taken for test. The drop test which it must pass is the same as for steel, except the five blows are from a height of 23½ feet.

Metal Underframing for Freight Cars.

R. P. C. Sanderson, J. D. McIlwain, J. R. Skinner, John Player, Committee.

With the gradual and steady increase in the carrying capacity of freight cars and in the hauling power of freight locomotives, the insufficiency of the earlier methods of freight-car construction, developed from wagon building, consisting of timber framing held together by nails, spikes, straps, lag-screws and bolts, became more apparent.

The lessons learned on the repair tracks led to the strengthening of freight-car body bolsters and longitudinal sills with truss roads, and, finding this to be still insufficient, the timbers have been reinforced with iron and steel as in the well-known flitch-plate bolster, or in the fairly effective plating of bolsters, end and longitudinal sills.

Some designers, recognizing the inherent weakness in any composite form of construction where wood is used, went at once to iron for body bolsters, of which there are numerous designs of the built-up type. Here should also be mentioned the Schoen pressed steel, American and Shickle, Harrison & Howard cast-steel body bolsters, which have been extensively illustrated in the technical journals and are well known to the members.

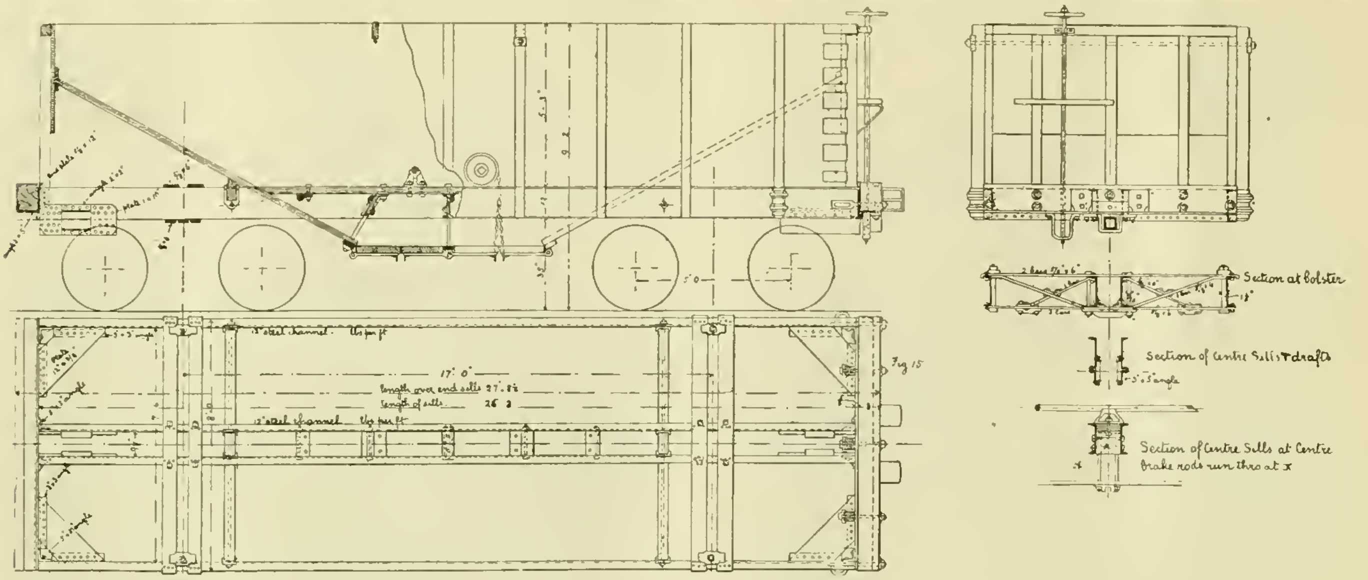
The Chicago, Burlington & Quincy Railroad car (See American Engineer for March, 1896) marks a long step ahead in that the center sills, as well as the bolsters, are of steel. It is very probable that the use of iron and steel in car construction would have advanced far beyond its present standpoint but for prejudice which has grown up in the minds of many against any and all iron or steel cars, as the result of some unfortunate ventures in which the designers either did not fully understand the service and strains a freight car has to withstand, or from lack of experience, and in an endeavor to keep the weight and cost of their cars down to limits which would enable them to make sales, placed cars in service that have become a by-word on account of their frequent and prolonged sojourns on the repair tracks.

It would be quite as unjust to condemn all iron or steel car construction on account of these failures as it would be to condemn the use of wood in car construction because some of the earlier builds of cars, and even some comparatively recent designs, are so poorly proportioned that they are constantly failing. The obviously proper course is to profit by these early failures in iron car construction, make use of the experience gained and go on with the development of the steel car frame, trying to avoid the errors of the past. It is only necessary to remind those present of some of the exhibits at the Chicago Exposition to show that progress has been made in the right direction.

Even if the members of your committee felt that they could present a design for standard steel framing for freight cars which would be practically perfect and require no future modification (which is not the case), it would not be practicable to do so until greater uniformity in the lengths and sizes of interchange freight cars for given capacities has been brought about. It is to be hoped that a thorough inquiry into the subject will be made by the Association by means of a committee to recommend standard lengths of sills and widths over sills for refrigerator, box, stock, flat, drop-bottom and drop-end gondola cars of 60,000, 70,000 and 80,000 pounds capacity, and that the Association will adopt such standards.

After this step has been taken, then, with sufficient experience and knowledge to guide them, a committee could take up the subject of steel underframing for freight cars, and, with good hope of success, present to the Association a series of designs for M. C. B. steel underframes that could be adopted and used, as far as their general features are concerned, without fear of serious failure ensuing.

As long as the main framing of foreign freight cars coming on our repair tracks is of timber (which can be cut and dressed to suit by the ordinary carpenters' tools), and of iron truss-rods and bolts (which can be cut or welded by any blacksmith), odd sizes of sills, etc., are not such a serious matter, but when we come to steel and iron, which



Steel Framed Hopper Car of 60,000 Lbs. Capacity—Norfolk & Western Railroad.

Total light weight of car 29,800 lbs., or 1,500 lbs. more than weight of same class of cars with wooden sills.

require heavy machine tools and shop treatment, and where odd sizes or shapes must be specially ordered and rolled or forged at the forges or mills, the question of uniformity of sizes becomes one of paramount importance.

With standard lengths, depth, width of flange and weight per foot for sills of all flat-bottom cars of 60,000, 70,000 and 80,000 pounds capacity, the rolling mills can carry the stock ready for instant shipment, feeling safe that they will not have it left on their hands as obsolete stock; the sills and shapes in stock at any railroad shop store would be certain to suit any foreign car that might come on the repair tracks, only requiring that the holes, etc., should be laid off and punched or drilled to suit the details of the particular car, but before this happy state of things can be brought about, the standards for lengths and widths of cars must be adopted, and—when steel-framed cars are built—rigidly adhered to.

Pending the adoption by the Association of the standard lengths and widths for given capacities, your committee present the following rules or recommendations, which they feel justified in asserting should be seriously considered by designers of steel framing for freight cars.

First. Especially forged, pressed or rolled shapes, cast steel, etc., or patented forms of construction are undesirable for cars to be used in general interchange business, no matter how well designed theoretically, for the reason that when such parts are damaged there must necessarily be long delays in ordering and obtaining these special parts, and should the parties who have furnished them go out of business, or change their molds or patterns, the parts cannot be duplicated for repairs except at enormous expense and loss of time.

Second. Steel and iron bars and shapes of standard bridge specifications and regular market sizes should be generally preferred, so that railroads and car builders can avail themselves of the competition in the open market when purchasing, or if not equipped to put steel frames together themselves, can have this work done for them at any of the numerous bridge-building concerns on competitive bids. The underframes, riveted or bolted together, can be shipped by carload lots to the car shops to be completed into finished cars.

Third. Get-at-ableness in the design is of the greatest importance in keeping down the first cost and maintenance; parts that are to be riveted together should be so arranged that they will be equally convenient for hydraulic or power riveting when the car is being built, or for field riveting in repair work.

Fourth In designing riveted work, it should be laid off with plenty of rivets, these to be spaced close, as in boiler work, and the same care to insure true fair holes, hot rivets, well driven and completely filling the holes, as in first-class boiler work, is necessary. Complaints sometimes heard against riveted work in car frames and tender frames, on account of loose rivets, can be directly traced to an insufficient number of rivets and poor riveting.

Fifth. If bolts are used to hold iron or steel parts in position, not merely to carry weight, they must be turned bolts (a driving fit), in carefully reamed holes, fitted with the greatest care. When so fitted they will probably give no trouble from working loose, but as this is machine-shop work, such bolts should be avoided as far as possible, as it is not likely that such bolts will be fitted in this way on the repair tracks, while it is reasonable to expect that a hot rivet, well driven, can be put in anywhere with the aid of a portable forge. In both riveted and bolted work it is of the utmost importance to perfectly fill the holes, remembering that it is the "initial wiggle," if only 1-1000 part of an inch, that will surely produce loose rivets and bolts and oblong holes; no amount of hammering on the heads of rivetors tightening up nuts or bolts, or the use of lock-nuts, nut-locks or fibrous washers will be of any use if the holes are not perfectly filled.

Sixth. Every structure has a foundation, every machine has a bed-plate, every animal, bird, fish, and most of the higher works of nature, have a backbone or spine on or around which the structure is framed; this cardinal principle of design seems to have been largely overlooked in freight-car construction, and it is believed that the center sills of a freight car should be made its main strength and reliance, and that the entire load shall be carried from the platform, the upper works being simply arranged as a housing to confine and protect the load.

Seventh. To enable the center sills to withstand collision and severe shocks to the best advantage, these sills should be spaced so that they will be directly in line with the dead blocks, and thus take the buffing and collision shocks in direct compression. Also their depth should be such that at least the center line of draft and centers of the dead blocks will be within the vertical dimensions of the sills. When so arranged there will be no tendency from shocks or pulling strains to bend the center sills, either laterally or vertically, or to bend or break the end sills.

Eighth. That care should be taken to avoid punching or drilling holes in the flanges of channels or I-beams where these are subject to heavy strains, especially tension or bending strains, unless additional meterial is added to compensate for this.

Ninth. That with the change from wood to steel the necessity for truss rods no longer exists for cars of reasonable lengths, but that ample and sufficient strength can be obtained within reasonable limits of weight without the use of truss rods and consequent need of adjustment.

Tenth. On account of the sweating and rusting of iron and steel, wood is preferable to iron or steel for flooring, siding and lining of merchandise and stock cars. Much has been said and written on the subject of corrosion of iron and steel brake beams, bolts, pipes, rails, etc., from the action of sulphuric acid leachings from coal cars and salt-water drippings from refrigerator cars and manure drippings from stock cars.

There is no doubt that there is serious corrosion from these and other causes under certain conditions, but evidence exists that steel framing under tenders and iron work under coal cars in constant service, and steel framing of cars exposed to very damp and destructive climatic influences for many years, have not suffered materially from these causes. Doubtless preservative paints can be found that if properly used when the steel frames are first built and with occasional repaintings will sufficiently protect the steel from corrosion, but as this is a very important subject your committee would recommend that it be made a special subject for committee investigation by a series of tests ranging over nine or ten months' time.

There is an economical side to this question which your committee desire to call attention to before closing their report, namely, how much additional weight and how much additional first cost dare be put on a car without ultimate loss.

First. As regards the question of increased light weight of freight cars of given capacities having steel underframes, your committee feels that they need only state that it is proven to be quite practicable to build cars with steel frames of greater strength and capacity with less light weight than when wooden or composite underframing is used, and that with more experience in the right methods of construction and a proper appreciation of the capabilities and best uses of steel, the proportion of carrying capacity to light weight can be still further increased for large capacity cars without danger of increasing the subsequent running repair account.

Second. With regard to the questioo of probable increased first cost of freight cars having steel underframing, the burning question here is, "Will it pay?" There are so many factors governed by local conditions which must enter into the calculation that each company must perforce figure this out for its own set of conditions.

One factor, namely, the repair account should, however, here receive passing notice. From the best information obtainable your committee believes that it is very nearly correct in stating that the charge for wheels, axles, springs, paint, chain, brake shoes, brasses, couplers and other parts that will wear out and fail as much under the most perfect steel-framed car as under the poorest design of wooden-framed car in the same service will constitute about 50½

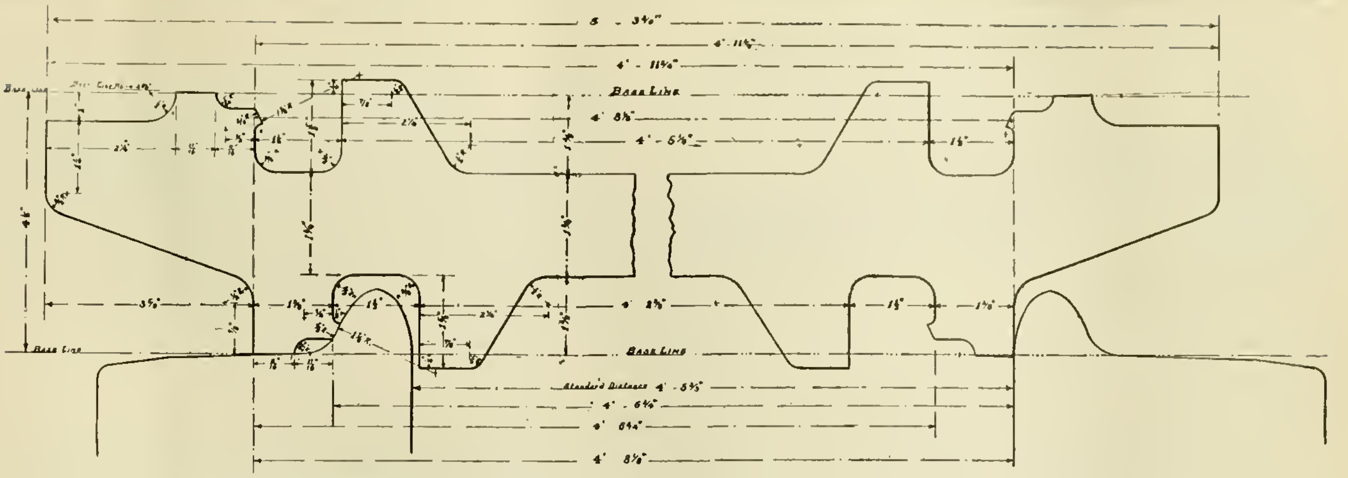


Fig. 1.—Standard Reference Gage for Mounting and Inspecting Wheels.

per cent. of the average total cost of freight-car repairs, exclusive of inspection, oiling and packing. Then the two question remain:

First. Of the remaining 49½ per cent. how much can probably be saved by the use of a perfect steel underframing which would require no repairs except painting during the life of the car?

Second. Will this saving, added to the increased freight earnings of the car and to the increased mileage earnings when away from home (due to a less number of days per annum spent on the repair track), pay the interest and depreciation on the extra first cost of the steel car?

Taking the figures given in "Poor's Manual," the freight earnings per revenue car for 1894 were about $1.38 per day, and the average mileage earnings of cars away from home are only about 15 cents per day.

Where the freight-car repair work is being kept up currently, the number of cars on the repair tracks can be kept down to 4 per cent. of the total equipment; this means that each freight car would spend about fourteen and one-half days on the repair tracks each year. If we assume that only 40 per cent. of this could be avoided by the use of perfect steel framing, we can possibly save about six days on the repair tracks per annum.

This would mean, if the freights were available, increased freight earnings of $8.28 per annum per car, or 90 cents additional mileage earned per annum per car away from home.

It is about right to assume, including private cars, that 30 per cent. of all freight cars are constantly away from home.

Taking one lot of 1,000 cars we can assume that as above the freight earnings could be increased........	$8,280.00 per annum
The mileage earned from foreign roads increased	300.00 " "
	$8,580.00 " "
Estimated possible saving in repairs, say 20 per cent. of $72 per car per annum....................................	14,400.00 " "
	$22,980.00 " "

As the steel framing when put up in lots by bridge builders ought not to increase the cost of cars more than $75 per car at most, this figure of $22,980 per thousand cars for savings and increased earnings would approximate 36 per cent. per annum on the extra capital invested, amply sufficient to cover the depreciation and interest charges under the conditions above assumed.

At the time of closing this report it is learned that the Illinois Steel Company is at work on designs for steel cars, drawings for which it is hoped will be received in time to present to the convention. It is also expected that a Norfolk & Southern steel flat, Norfolk & Western steel flat and steel framed hopper, Pennock steel car, Carnegie and Illinois Steel Company's cars will be completed and on exhibition at Saratoga for inspection by the members.

[The report is accompanied by drawings of the Norfolk & Southern steel flat car (illustrated by us in March, 1894), the steel bolster of the Northern Pacific (see our issue of March, 1896), the C. B. & Q. car with steel sills (in our issue of March, 1896), the Norfolk & Western steel flat and hopper cars of 20 tons capacity, a proposed design of steel frame for a 36-foot 30-ton car submitted by Messrs. Sanderson and Wentworth, the Pennock steel car, Trapp's 80,000-pound steel car, Player's steel frame and Carnegie Steel Company's hopper car of 100,000 pounds capacity. The latter cars weighs 39,000 pounds light. Some of these cars not already illustrated by us, and not found herewith, will be published later in a more complete manner than would be possible at present.—Editor.]

Mounting Wheels.

J. N. Barr, R. E. Marshall, J. C. Barber, Pulaski Leeds, J. H. McConnell, A. M. Waitt, Thos. Sutherland.

The committee believes that the standard dimensions for wheel gages, as given in the Proceedings of 1895, are proper. In consideration of the check gage for mounting wheels, as shown in Plate 12, and the standard wheel gage, as shown in Plate 7 (M. C. B. Proceedings, 1895), it believes that these two gages should be combined, as shown in Fig. 1, and that the term "Standard Reference Gage for Mounting and Inspecting Wheels" should be applied to the combination.

It does not think that the gage in this form is suitable for practical work, either for mounting or inspecting wheels, but is more properly a reference gage; and it is for this reason it has suggested the name above. Attention is called to the fact that a slight change is made in the gage by enlarging the surface which comes in contact with the outside of flanges.

For the purpose of practical use in inspecting mounted wheels, both in shops and on the road, your committee presents a design, shown in Fig. 2, to be entitled "Standard Check Gauge." The only dimensions in this gage which differ from that shown in Fig. 1 is the distance between gage points, which is 4 feet 8¼ inches instead of 4 feet 8⅛ inches; but as this dimension is not used in inspecting, the discrepancy is immaterial.

The following instructions for using the proposed check gage explains all points in connection therewith:

INSTRUCTIONS FOR USING STANDARD CHECK GAGE.

In using the proposed check gage, if the projections *A* and *B* do not enter between the flanges, and the projections *C* and *D* rest upon the treads of wheels, the wheels should be rejected.

If the projection *A* is pressed against inside of the corresponding flange, the projection *C* resting on the tread, and the projection *F* does not allow the projection *D* to rest on its corresponding tread, the wheels should be rejected.

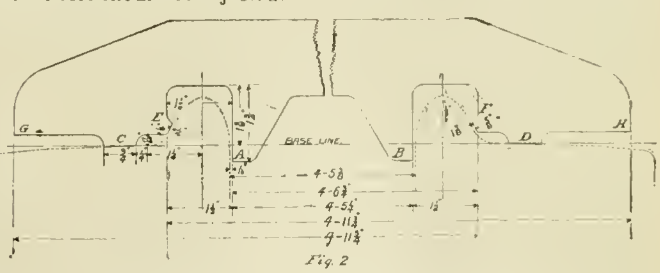


Fig. 2.—Standard Check Gage.

Also, if *F* and *D* are pressed against the flange tread of wheel, and *C* does not come in contact with tread on account of *E*, the wheel should be rejected.

If *E* and *C* are pressed against flange and tread, and *H* extends beyond the outside of tread, the wheel should be rejected.

The same if *F* and *D* are pressed against flange and tread, and *G* extends beyond outside of tread.

Your committee presents, in Fig. 3, a light and simple form of gage for mounting wheels symmetrically on the axle. This gage has been in practical use for over a year and gives very satisfactory results. For those desiring to mount new wheels from the outside of the flange, a suitable modification can readily be made. In the case of second-hand wheels, however, it is the opinion of your committee that the best practical results will be obtained by mounting from the inside of flange, and it is also the opinion of some of the members of your committee that the above remarks are equally true in the case of new wheels.

The committee believes that the best results will be obtained by the constant use of the proposed Standard Check Gage, at three or more points on the periphery of the wheels after mounting, as a positive guarantee of conformity to standards.

Your committee desires to urge upon all members of the Association the use of the standard maximum and minimum flange gages as a test requirement for all new wheels purchased before fitting them to axles.

In conclusion, it would summarize its recommendation as follows:

RECOMMENDATIONS.

First. That a standard reference gage for mounting wheels, covering the standard dimensions, shown in Fig. 1, be adopted, which shall combine the present check gage for mounting wheels, shown in Plate 12 of 1895 Proceedings, and the standard wheel gage, shown in Plate 7 of same year, the new combined gage to supersede the other two.

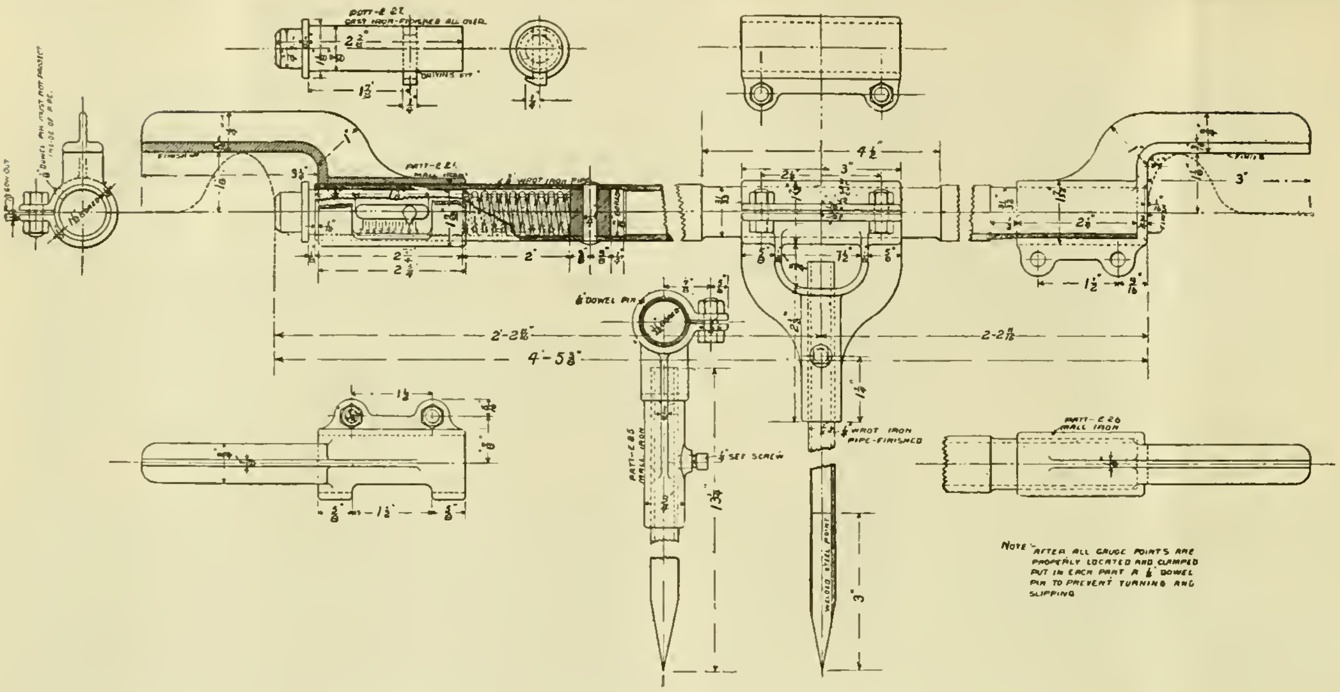


Fig. 3.—Gage Recommended for Use in Mounting Wheels Equi-Distant from Centers of Axles.

Second. That a standard check gage be adopted as shown in Fig. 2.

Third. That a gage for determining the center of the axle between centers of journals be used.

Fourth. That a gage for locating wheels equi-distant from the center of axles, as shown in Fig. 3, be adopted as recommended practice.

Fifth. That all axles be carefully centered between centers of journals prior to mounting.

Sixth. That wheels with flanges worn to a thickness of 1⅛ inches or less should not be remounted.

Seventh. That, as far as possible, the thickness of flanges of wheels fitted on the same axle should be equal, and should never vary more than ⅛ inch.

Eighth. That in mounting second-hand wheels, they be mounted to the standard distance between inside of flanges.

Freight-Car Doors and Attachments.

F. H. Soule, J. J. Casey, W. J. Robertson, B. E. Thomson, Thos. Fildes, Charles Waughop, A. J. Cromwell, Mord Roberts, Committee.

Your committee, appointed to report on the latest improvements and best practice in freight-car doors and attachments, respectfully submits the following data derived from the replies to circular of inquiry, indicating the kind of door standard to the several roads, and embodying therein the latest improvements in door attachments:

1. Total number of roads replying to circular 28, representing 274,434 cars.
2. Standard door on 13 roads, representing 123,810 cars, "Dunham."
3. Standard door on 3 roads, representing 40,614 cars, "Wagner."
4. Standard door on 3 roads, representing 7,851 cars, "Moore."
5. Standard door on 1 road, representing 17,469 cars, "Safety."
6. Standard door on 1 road, representing 22,438 cars, "Eubank."
7. Standard door on 1 road, representing 213 cars, "Lone Star"
8. Standard door on 1 road, representing 6,553 cars, "Kanaly."
9. Standard door on 2 roads, representing 27,352 cars, "Old style sliding on bottom rail."
10. Standard door on 3 roads, representing 33,134 cars, "Old style top hanger, sliding on flat iron."
11. Special safety brackets at bottom of door to prevent opening of door without breaking of seal are standard on six roads, representing 105,297 cars.
12. Special designs for door fastenings.
13. All but three of the twenty-eight roads employ the "batten" form of construction.

Your committee does not understand that its appointment contemplates a report on the merits of any particular device, or that the detail for recommended practice or standard door should be submitted. As covering, however, in a general way, the special features desirable in connection with an ideal freight-car door for box, stock and other classes of freight-car equipment, your committee would respectfully recommend that:

First. The door should be so constructed as not to be liable to bind or give trouble in working on account of swelling or warping slightly.

Second. The door should be hung at the top with no rail at the bottom which can be bent, and, from being bent, interfere with the free running of the door.

Third. The door should be hung so as to move readily by a small amount of force when applied either at the bottom, middle or at the top.

Fourth. The door should not move easily enough to roll back and forth by the alternate forward and backward jerks that the car gives in a freight train.

Fifth. The door should be so arranged as to be weather and cinder proof at the top, bottom and both sides when closed.

Sixth. The door should be so constructed that when it is locked and sealed, it would be impossible, without breaking and mutilating the door, to pry open the back end or bottom of the door, so as to permit entrance of the hand or hook to pull out portions of the lading.

Seventh. The door should be so constructed that if the lading presses against it and bulges it out from the inside when it is closed, it cannot be pressed away from the car so at to swing out and strike passing trains or other objects at the side of the tracks.

Eighth. The door should be so constructed as to make it absolutely proof against unhanging; excepting where the stop, against which it rests when open, is removed and the door taken off in the regular way.

Ninth. The door should be so constructed as to prevent it swinging out when in its closed position, even though all of the bottom brackets are removed.

Tenth. The door should be so constructed as to be proof against swinging out when in its closed position, in case one of the hangers should be broken or lost off.

Eleventh. The door should have such a style of locking arrangement that it cannot be removed or tampered with from the outside, without at once making the fact known to the seal record taker as soon as he sees the fastening.

The above conditions should be considered as applying to end doors as well as side doors, with special reference to locking arrangements, which should have the same or equal provisions for sealing. In this connection, and for such action as the Association may be pleased to take, a communication from Mr. John T. Denniston, President Freight Claim Association, is submitted, in which he asks whether this Association "could adopt a resolution requesting that all roads owning cars with end doors would make provision thereon that they could be sealed on the outside, so that a proper record could be obtained to enable the freight-claim agents in handling claims to properly locate the liabilty therefor."

In conclusion, the committee would refer to the danger to life and property incurred in the handling of private line cars equipped with hinged doors swinging outward. In the opinion of the committee such doors are much more dangerous to passing trains than any other type of freight-car door extant. Such doors are inherently dangerous, from the fact that if unlatched they will gravitate to open position on the slightest oscillation of the car. Again, in many cases, they swell to such an extent as to prevent them from closing properly. The fastenings are also continually getting out of order.

The committee is in hopes that the Association may take some action that will prompt the private line people to the adoption of some safer form of door.

Handholds and Height of Drawbars.

This report is simply a more complete presentation of the practices recommended by the committee as desirable and conforming to law, which was outlined in a statement furnished by them and issued by the association in August last. That statement, together with the diagrams accompanying it, can be found in our issue of September, 1895.—[Editor.]

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

AUGUST, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

II.

(*Continued from Page* 93.)

The proceedings of the two conventions held in Saratoga in June occupied so much room in the July number of the AMERICAN ENGINEER as to crowd out the second article on the Altoona Shops. As it was thought that this could be written better on the ground than from notes made during a previous visit, a second journey was planned, partly to escape the heat of New York and to enjoy a sojourn among the hills, where Altoona is located, and also to refresh recollections of the subjects noted in a previous visit. Having a decided aversion to sleeping cars when the thermometer is in the neighborhood of the nineties, the train which leaves New York at 2 P. M. was chosen for the journey. At that hour the thermometer was balancing in the vicinity of 90 degrees or above, and therefore an ordinary coach was taken at Jersey City in preference to a drawing-room car, for the reason that the latter are apt to be insufferably hot in warm weather when they are run in vestibuled trains. In coaches windows are kept open, and a circulation of air is thus obtained, whereas in drawing-room cars there seems to be some reason why the windows must be screened if they are opened, and ordinarily there are only a few screens for the many windows. The coach selected was immediately behind the dining car in the same train. A brisk westerly breeze was blowing into the great trainshed in Jersey City, with the result that the combined odors from the kitchen of the dining-car were wafted into that behind it. This is often, and was then, very disagreeable in vestibuled trains, but is especially so on a hot day. After theorizing about bad smells a good deal the conclusion reached is that there are a great many railroad men who are color-blind in their noses. As evidence of this it may be said in designing drawing-room and sleeping cars, instead of putting the door of the smoking-room toward the end of the car, they are often placed so that they face toward the middle of it, or possibly toward its side, so that when a current of air enters the front end door, as it will when the train is in motion, it drives the smoke from the apartment where bad cigars are consumed and worse stories are told, into the middle of the car. In the much vaunted but viciously ventilated vestibuled trains a carefully constructed conduit is provided which carries the bad smells and the foul air from one end of the train to the other, so that the occupants of the rear cars must breathe a sort of atmospheric hash consisting of the odors of tobacco, multitudinous smells from the kitchen and scullery of the dining-cars, the exhalations from the lungs and bodies of washed and unwashed travellers, and when the latter take their boots off the air literally becomes *fetid*. This conduit is constructed at great expense, it adds largely to the weight of cars, is an obstruction in getting in and out of them, makes the train harder to pull, and forms a sort of trap for colleeting microbes and the seeds of disease and death. There are trains of this kind which also run out of the Pennsylvania station in Jersey City, the cars of which are marked "*F. F. V. Limited*," which connect with some of the Virginia railroads. A traveller, who took one of these trains, and found the ventilation very bad, interpreted this lettering to mean "fright-fully ventilated." Our criticism is that vestibules make trains very warm in summer, and that by preventing the escape of bad air, and the entrance of that which is pure between the cars, they make good ventilation more difficult than it is without them; that ingress and egress to and from the cars is more inconvenient than it is when vestibules are not used; they are expensive and heavy, and the advantages do not compensate for these disadvantages. Simple gates in the platforms would make the passage from one car to another secure, which is all that seems to be demanded.

It is not often that any good reason can be found for criticising the Pennsylvania Railroad cars. There is though, it is thought, good ground for finding a little fault with the fastenings of the windows and blinds in some of their coaches. In the first place there is no provision made for holding the window sash or the blind in any position in which it may be desirable to have it. There is but one stop so that the window must be wide open or closed entirely. Often it is desirable to have the sash raised only a few inches, and the blind lowered part way to keep the sun out, but not to obscure entirely the view. The fault with the fastenings is that some of them will not fasten, and one blind could not be moved at all. Surely the mechanical genius of the Pennsylvania Railroad is able to devise something more effective than what they are now using. Of course these are hard times and what with the threats of free silver, bad business and general distrust we probably will be obliged to be content with defective sash locks, at least for the present.

After emerging from Jersey City the first greeting was a prolonged whiff of bad odors from the manure piles on the meadows near the Pennsylvania Railroad shops. One cannot help but drop a word of sympathy for the masters in charge, and the men employed in these shops who must endure the stench which exhales perpetually from this locality. Happily for mankind it becomes accustomed to all sorts of disagreeable things, odors among others, and our friend the editor of the *Master Mechanic* intimates that he enjoys vile perfumes such as tobacco, onions and skunks, and seems to thinks that those who do are in some sense superior to those who do not. The train swung through Newark and then to the real country, which God made, and we soon glided to the leeward of a hay-field, with real hay-cocks, and the aroma of new-mown hay. Thanks to Colonel Waring, the the odor of the streets of New York is not as bad as it was in the days when Tammany held sway, but even now the metropolitan atmosphere in July is not suggestive of perfume, so that the smell of the hay-field, as it was swept into the windows of the car, seemed like incense, and suggested the experience of long ago when hay-making was one of the occupations of the writer and he was free from the drudgery of squeezing ideas out between the nibs of a pen. How fresh and grateful the country looks to one who sees daily little excepting bricks and mortar! In some of the fields the grain was freshly cut, the corn just ready to burst open with its crown of glory, the grass and foliage in its full midsummer luxuriance, and every tree seemed to be clad in coronation robes in honor of us poor mortals who come to look upon them. Verily those of us whose daily lives are spent apart from these glories, of which nature is so lavish, loso much that makes life worth living.

The 2 P. M. train is a fast one, so we were whirled through Elizabeth, with its new elevated railroad above, and clear of the the New Jersey Central crossing where for so many years the only guardian angel who stood between death and thousands of people who traveled on the two roads was a faithful Irishman with a red flag by day and a red light by night. Happily the danger of this grade crossing is now non-existent, and the traveler who knew of it is no longer obliged to hold his breath—as some of us did—every time we reached this dangerous intersection of two roads. Rahway came and vanished. New Brunswick, with the quiet college shades in sight of the road, as we whirled past the old superannuated station; Princeton Junction, with the trees and spires and towers of the seat of learning in view, in the hazy distance, all robed in the panoply of midsummer. To a person who has traveled for nearly half a century by rail between New York and Philadelphia, it is a little unexpected to pass through Trenton without being delayed, and without stopping or being greeted with the cry of peripatetic train boys of "fried oysters and ham sandwiches." The train on this occasion did not stop. Trenton is the seat of Jersey politics and potteries. The train crossed the Delaware River quickly on the strong iron bridge, which recalled the old creaky wooden structure which years ago occupied this place and had to be crossed at reduced speed, and also brought to mind that it was not very far from the site of the bridge that Washington made that celebrated crossing of the Delaware on a Christmas eve, the sequel to which was of such momentous consequence to all of us.

On the Pennslyvania side of the Delaware the canal and slow-moving boats was suggestive of the past, and a number of bicyles and riders on the tow-path were indicative of the present. The contemplative canal-boat and the ruminant mules made a strong contrast with the alertness of the riders as they appeared in the shaded path which would have made a good subject for a picture representing the past and the present.

In Pennsylvania the well-cultivated fields were soon in view; there were more hay and grain fields, luxuriant corn, market gardens, green trees—beauty, fragrance and delight. The outlying suburbs of Philadelphia, which extend almost all the way to Trenton, with their shops and factories, looked warm and uncomfortable in the July temperature; but the air of comfort of many of the residences is unmistakable. The outlying portions of Fairmount Park were soon reached with its pathetic bronze statue of the wounded lioness, below the railroad the Zoological Gardens, the Art Gallery—a reminder of the Centennial Exhibition—which it seems impossible could have been held twenty years ago, and then a brief stop in the Philadelphia depot, which was hot and stifling, and after the seats were reversed the train was again headed westward.

A glimpse of the well-equipped repair shops of the Pennsylvania road, a rather smoky and dusty ride through the long yard, where there is an ascending grade, extending for some miles beyond, and we come to the matchless suburbs of Philadelphia, where her well-to-do people have made their homes.

A touch of tropical luxuriance seems to be apparent here, if we compare the foliage and the landscape with that east of the Delaware River. The ground west of Philadelphia is beautifully rolling, with groves of magnificent trees—oaks, chestnut and walnut. Some kinds appear here, such as the catalpa. Lombardy poplar, tulip-tree, sassafras, etc., which are not common in New Jersey. Truly it is a goodly land, and those old companions of William Penn acted wisely when they placated the Indians and took up their residence here. The wealth of Philadelphia has been lavished on this region. For a distance of 20 miles or more from the city there is a continuation of beautiful houses with ornamental grounds which nature, art and a protective tariff have combined to beautify. Many of the officers of this great road live in these places, and every facility for getting to and from their homes is given to the residents. Beautiful and convenient stations are located all along this portion of the line, and if the highest achievement of man, as it is said to be, is the creation of beautiful and happy homes, the residents here have certainly accomplished part of that end.

On the date of the journey which is here described the country was at its best. Recent rains had developed the foliage of the trees, the grass and the crops to their full perfection, and the heat of summer had not yet parched or withered any of them excepting the new mown hay. To a tired journalist baked and parched like a ball of pop-corn, and wearied by a metropolitan struggle for existence, the walks, verandas, nooks and shady places and well-made roads looked exceedingly attractive. What capacity for work such daily refreshment must give, what contentment and felicity must come if the household in such houses accords with their external appearance.

After the top of the long grade was reached the shower of cinders was less copious and exasperating. The magnificent view of Chester Valley was then revealed from a high ridge, which had been gradually ascended from Philadelphia. It would require the descriptive powers of Sir Walter Scott or Ruskin to do it justice. Here the suburban residences of city people are no longer seen and the homes of the true rural residents of Pennsylvania are indigenous. The land seems to exude fertility and fatness, and prosperity and comfort are apparent everywhere. In one of the fields a reaping machine was sweeping away the golden grain, a wagon with a typical team of Pennsylvania horses and attendants, fat as the horses, in a grayish afternoon sunshine, the distant hills, hazy and soft in their outline by reason of a light veil of cloud which hung over it all made a beautiful scene. But the accusation of an attempt at fine writing will hold if this vein is continued, and as this article is intended to be descriptive of railroads, and not beautiful scenery or Pennsylvania farms it must be enough to say that the train glided on and on continuously, with only a slow up at a junction, from Philadelphia to Harrisburgh, through the surpassingly fertile and well-cultivated farms of Chester and Lancaster Counties, than which there is perhaps no richer farming land in the world. A brief stop in Harrisburgh after nightfall and the train again sped its way westward. A comfortable dinner in the dining car followed, but observation of the landscape was shut off by the darkness. Dining might be called an excercise of introspection, and to that an hour was devoted satisfactorily. About as much more time elapsed and the electric lights about the Juniata shops came in sight, and we were soon comfortably housed and roomed at the Logan House. Nothing which would interest our readers elapsed between then and the next morning, excepfing that appointments were made to visit the shops and plans were formed for seeing and hearing whatever could be learned and observed that would be likely to interest the reader and the writer.

CLASS L ENGINES.

Our first article on the Altoona shops contained a view made from a photograph of one of the recently built Class L engines, with a view taken at the same time, and on the same plate of a class G engine, built in 1873, which showed in a very striking way the difference in size and appearance of the two engines. It was then promised that a fuller description of the most recent of these would be given. Through the courtesy of the able head of the department of mechanical engineering at Altoona we are able to give the a diagrammatic view on page 168 of one of these engines, of which some thirty or more have been built, and which are giving excellent service, and we are also indebted to the same source for the following data concerning them:

Their cylinders, as will be seen from the diagram, are 18½ by 26 inches; the driving wheels are 80 inches in diameter; the grates 10 feet long, and, as the firebox is on top of the frames, the width inside is about 42½ inches; the barrel of the boiler is smallest next to the smokebox, where it is 60 inches diameter, from which it tapers backward to a point about midway between the smokebox and firebox, where the tapered portion unites with a cylindrical ring or plate 68 iuches diameter. The location of the dome, etc., can be understood more easily from the diagram than it could be from a description.

The fire-box is of the Belpaire type, in the construction of which some important improvements have been made. The crownsheet is flat and horizontal both longitudinally and transversely. In order to allow of the upward expansion of the crown staybolts at the front end the two front rows and some of the ack stay bolts are fastened to the top plate, as shown in the sectional view Fig. 1 herewith, from which it will be seen that a brass thimble is screwed into the roof plate from the outside and the staybolt passes up through this without being screwed into it. A nut screwed on the top end of the bolt rests on a spherical washer, which has a bearing to correspond on the top of the thimble. A cap which covers the end of the bolt and its nut is then screwed in an external thread, on the thimble and serves to make this fastening steam tight. The illustration shows that the bolts are free to move upward, when the firebox is first expanded by the heat, and they are thus relieved of undue strains from this cause. When the shell becomes heated it expands and thus brings the washers to a bearing on the thimble. The ends of the bolts are riveted over the nuts, so as to prevent them from unscrewing. The lower ends of the crownstays are screwed into the crownsheet, but have button-shaped heads below the sheet, with rounded fillets between the heads and the threads on the bolt. Square heads are forged on the lower ends of the bolts to screw them in, but these are cut off after the bolts are in their position. The other crown bolts have similar fastenings in the crownsheet, but are screwed into the roof-plate and have a cap nut on the outside. The staybolts on the sides of the firebox are located as nearly horizontal as was practicable to permit the inside and outside plates to expand and contract as freely as possible without straining the bolts. The strains to which such bolts are subjected when they stand at a considerable angle to a horizontal line has been repeatedly pointed out, but notwithstanding that fact, the vicious

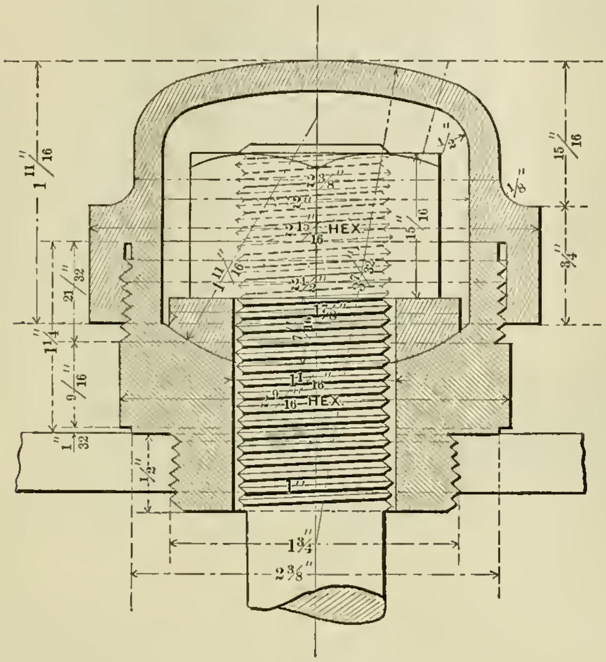


Fig. 1.—Expansion Staybolt.

practice of so arranging staybolts is still continued in many cases. The transverse rods over the crownsheet, which are so essential in the Belpaire boiler, are screwed into the plates and have an ordinary nut on the inside and a cap nut outside.

The water space on the sides and ends of the firebox is four inches wide, but the outside shell at the front end of the firebox is swelled out to the diameter of the largest ring of the barrel of the boiler. The square portion of the outside shell above the crownsheet is somewhat narrower than than the largest diameter of the shell so as to give as much room between it and the cab as possible. What may be called the swollen protuberance of the side sheets, back of the tubesheets, is gradually narrowed or "runs off to nothing" at the back end of the firebox. The object of this lateral extension of the side-plates, back of the tubesheet, is to give a convenient connection with the barrel of the boiler, but chiefly to give more water space between it and the firebox at this point.

The mud ring is double riveted all around. The radii of its inside corners are three inches. This permits the use of a number of rivets in each corner extending all the way through the metal of the ring. The outside contour of the angles of the mud ring are described from the same center as the inside corners are. The through rivets must therefore be radial to the inside and outside curves, and their outside ends are necessarily further apart than the inside ones are. Patch bolts are therefore screwed into the ring and pass through the external plates between the through rivets. The inside end plates have flanges to conform to the corner of the mud ring. The corners of the plates are reduced in radius as they rise above the mud ring and the flanges are made to correspond thereto.

The diagonal braces which are used to strengthen the ends of the firebox shell are attached to the flanges of trough or channel shaped plates riveted to the ends of the external shell. The same sort of attachment is used on the roof for thin braces. They have the advantage not only of providing a good fastening for the braces, but of stiffening the plates to which they are riveted.

The front plate of the shell of a Belpaire firebox is difficult to flange, and has been regarded as a serious objection to the use of this type of boiler. In these engines, instead of making it of one piece it is made in two. The lower part is made in one piece, and extends up on the sides to within about six or eight inches of the center line of the boiler. The top portion is also made in a separate piece and extends down on the sides to within about the same distance of the center line. The cylindrical plate which forms the back ring of the barrel of the boiler is then cut so as to connect these two sections of the end and to the side plates of the shell.

The horizontal seams are all made with butt-joints quadruple riveted. The outside covering plates are 6 inches wide and the inside ones 12 inches by ⅜ inch thick.

The smoke-box extension is made of a separate plate from the main part of the box. The latter has a wrought iron ring at the front end to which the extension is bolted. This is done so that it can be removed, which is often desirable when work must be done in the smokebox.

The inside arrangements of the smokebox were designed by Mr. Wallace, of this road, and of this we expect to publish an engraving before long.

Especial attention has been given to facilities for washing out these boilers. With this in view besides the ordinary wash-out holes in lower portion of the firebox, three holes, with caps bolted over them are placed in the under side of the barrel conveniently located in its length. The front and back holes are 3 in. in diameter, and the middle one 6 in. Two three-inch holes are also placed on top of the barrel, back of the front tubesheet, and two in the angles on each side of the top of the firebox shell, one pair being near the front on one side and the other pair near the back on the other side. Observation has taught in Altoona, as it probably has elsewhere, that an important element in keeping boilers clean is to have sufficient force to the stream of water which is used in washing out the boilers. Special attention is now given to this, and better facilities are being provided to furnish a water supply of adequate pressure for this purpose.

The grates used in the class L engines are of the finger-bar shaking type. The bars or shafts extend transversely across the firebox, the fingers being 10 inches long measured from the end of one to the end of that opposite to it. The bars, and the spaces between them, are ½ inch wide. At the front end of the firebox there are two dead plates which occupy 33 inches measured in the direction of its length, and back of these is a perforated drop plate 14 inches wide which can be turned so as to dump the fire into the ashpan. The grate-bars are carried on bearing bars of the usual form, bolted by lugs to the bottom of the mud ring. Special pains have been taken, of late, by the authorities in Altoona, to close up all openings around the sides of the firebox so as to exclude cold air from entering at such places. The object of this is twofold, one to keep the cold air away from the fire-box plates, and next to keep the fire away from them, as contact with the cold plates always has the effect of checking combustion. In the class of engines which is here described the bearing bars stand away from the sides of the firebox. In order to close the crevices which are thus left, cast-iron blocks are made which fit in between the bars and the plates, and with a sort of flange or head which laps over the top of the bar. These blocks are simply dropped loosely into the spaces referred to, and the flanges or heads close the openings. In some other classes of engines inclined plates are fastened to the mud-ring and bear against the sides of the firebox, and have joints formed by grooves in the plates filled with asbestos. This makes them almost air-tight.

The check valves are of a pattern designed by Mr. William Wright, chief draftsman, and are inside of the boiler. The valve itself is of a simple conical mushroom pattern, attached to a seat which is removable from the outside. Any injury to the feed pipes outside would not disturb the valve. The horrible accident, which occurred at Pittsburgh a good many years ago, when a whole car full of passengers were scalded, many of them fatally, by the

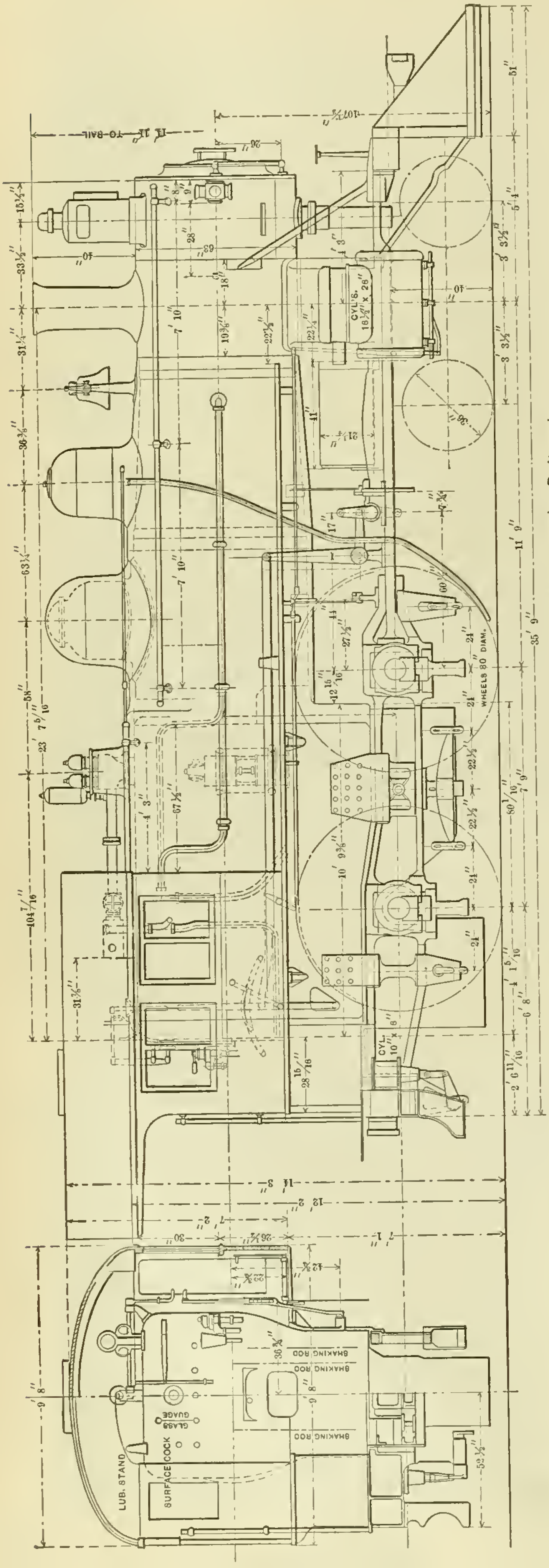


Fig. 2.—Outline Diagram of Fast Passenger Engines, Class L.—Pennsylvania Railroad.

water which escaped from the check valve of an engine, which ran into the rear end of a standing train, has led to the general adoption of inside checks on the Pennsylvania road. The example should be followed by other companies. Another feature, which has been adopted for greater security against such accidents, is cast-iron brackets for running boards. These are made very strong where they are bolted to the boiler, but the projecting part is made with only strength enough to support the loads which they must carry. A comparatively slight blow will break off such a bracket and leave the attachments to the boiler intact, whereas, if a heavy wrought-iron bracket is used, it is apt in a collision to pull out the bolts by which it is fastened to the boiler, and allow the steam or hot water to escape.

The long runs which are now required of passenger engines make it necessary to give especial attention to the oiling arrangements. Of course, ample bearing surfaces are a great help to lubrication. The links in the engines here described are made three inches wide, and they are so made as to provide suitable attachments for oil cups for oiling the pins, by which the rods are attached. Separate oil cups are also attached to the link hangers. The blocks instead of being made with the flanges on one side solid with the block, and a loose plate on the other, are both loose so that when they are worn they can be reversed from one side to the other. They are fastened with two bolts and two studs.

The crossheads and guides of these engines are of a new design by Mr. Vogt, Mechanical Engineer, which we hope to illustrate in a future number.

The piston-rods are fastened to the crossheads with a somewhat obtuse taper and with a bearing against the end of the rod. A rather "cute" expedient is adopted in making the slots in the piston-rods and crossheads. The key is of course tapered, and its back edge must bear against the rod to force it into the socket, and its front edge must rest against the crosshead. The slot in the rod is therefore cut square with the outside of the tapered portion of the rod, and consequently conforms with the tapered form of the key. The form of the back edge of the key slot in the rod does not matter because the key don't touch it. The slot in the crosshead is made square with the axis of the rod, and coincides with the back edge of the key, which stands vertical. The form of the front edge of the key seat in the crosshead is of no consequence because the key don't bear against it. It is therefore not necessary to make either of the slots tapered, which saves considerable work.

The rockers also have some peculiarities. They are made of wrought iron, the shafts being 4 inches in diameter. Between the two arms are two collars which divide the shaft into three parts, the two outer ones alone being used as bearings, which work in bronze bushings made in two parts and held in the rocker-boxes. The collars provide additional end-bearings to resist the wear of the rockers in that direction.

To avoid the awkwardness of making and of handling the lifting shafts when the arms are all forged on, the verticnl arm is made separate from the shaft. A circular flange is made on the end of the shaft and is turned up with it. The arm is then bolted to it with six bolts.

The main and coupling rods are fluted, the "big-end," as our English friends call the main stub-end, is of the forked pattern, and the coupling rods have solid ends and bushings.

One of the appliances which is used on these and other passenger engines on this road is the Moran flexible steam joint between the engine and tender, for conducting steam for heating the cars, from the locomotive boiler to the train. This is shown in Fig. 3, which is a view taken from near the ground looking upward from the engine toward the tender. The device consists of a system of ball joints and pipes which form a flexible steam-tight connection, to take the place of rubber hose. Fig. 4 represents an external view of one of these ball joints, and Fig. 5 is a sectional view. The principal feature in this joint, and which has made it successful when other joints have failed, is that it is made with a certain amount of play or looseness, and it becomes steam-tight by the internal pressure bringing the spherical surfaces in contact with each other, and holding them thus, so long as there is any pressure in the pipes. When there is not, there of course is no occasion for the joint being tight. A relief valve

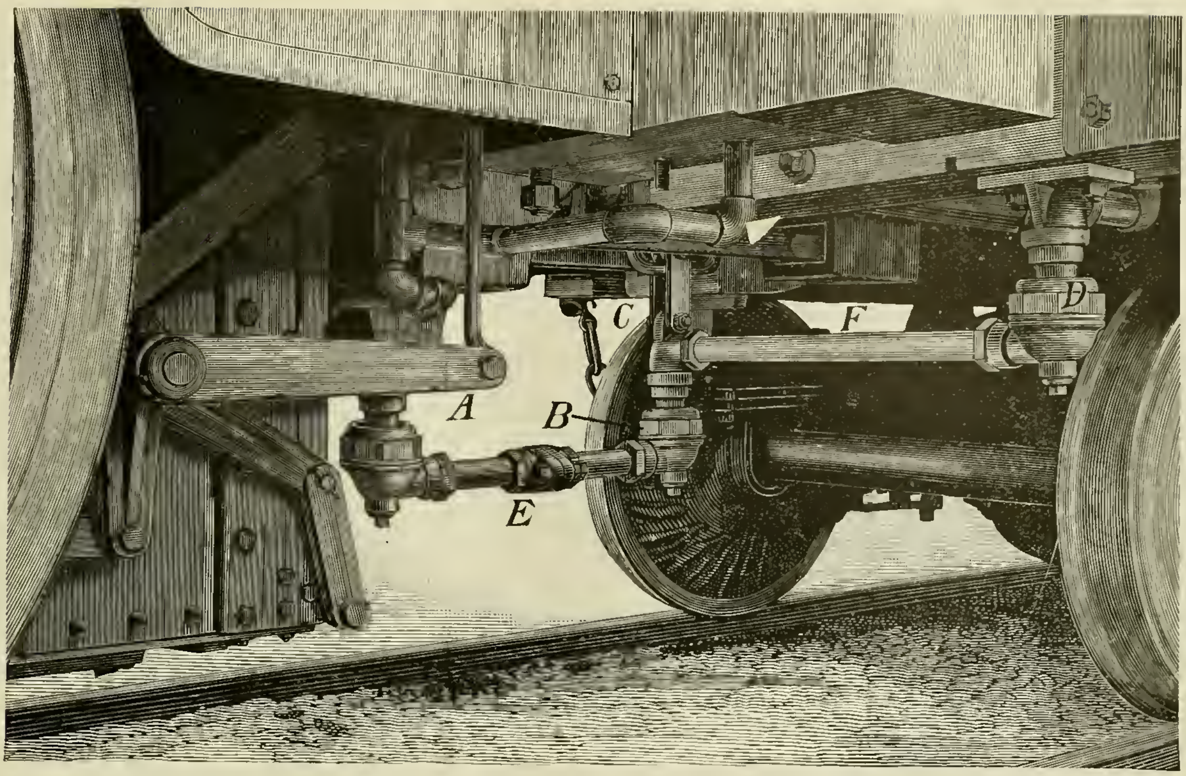


Fig. 3.—Moran Flexible Steam Joint Between Engines and Tenders on Pennsylvanin Railroad.

is shown in the lower part of Fig. 5, which consists of a ball which is raised by a spiral spring below it. When there is pressure in the pipes this ball is pressed down and on the seat below it is then tight, but when the pressure is released the spring raises the ball and allows any condensed water in the pipes to escape. Referring to Fig. 3, *A* is a ball joint connected to a fixed pipe in the engine. *B* is a similar movable joint, which is suspended by links *C* from a trolley above, which has a certain amount of longitudinal movement to compensate for that between the engine and tender. *D* is a third ball joint attached to a fixed pipe on the tender, which extends backward and connects with the train behind it. *A* and *B* are connected together by a pipe *E*, and *B* and *D* by a pipe *F*. As the latter stands crosswise and as *B* can move longitudinally, and all the joints are flexible, it is obvious that this form of connection can adjust itself to any position that the engine and tender can assume on the track when coupled together. This system of connecting pipes has been made a standard on the Pennsylvania road, and, it is reported, is working very satisfactorily, after a test of several years' actual service. The spherical portions are made of cast-iron and no difficulty is experienced in keeping them tight. The manufacturers are the Moran Flexible Steam Joint Company, of Louisville, Ky.

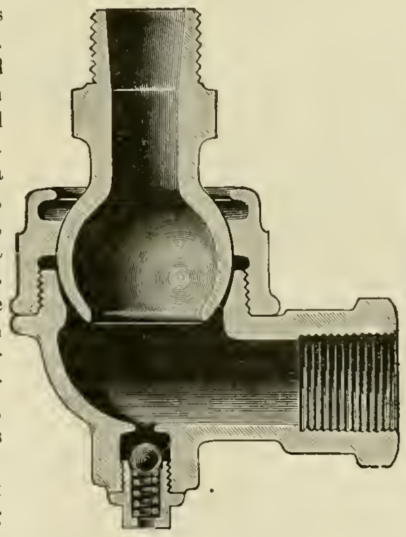


Fig. 5.

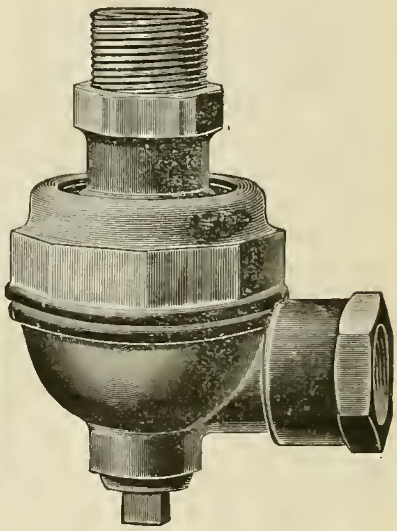


Fig. 4.

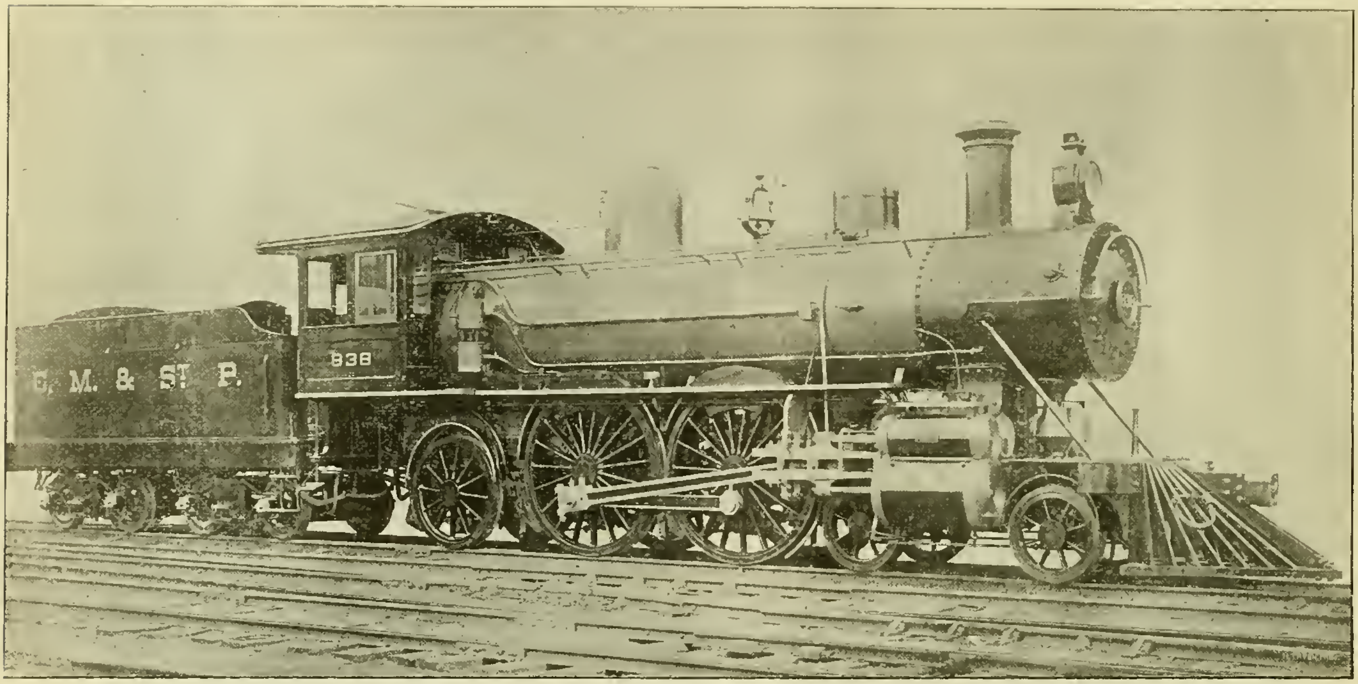
Views of Moran Flexible Steam Joint

In designing the cylinders of these engines care was taken to keep the steam pipes separate from the exhaust pipes, so as to avoid the cooling effect of the latter on the live steam. Ample provision was also made for draining both the steam and exhaust pipes. A cock is connected with the operating mechanism of the cylinder cocks, so that before the latter are opened the steam pipe can be drained, and it is kept open as long as the cylinder cocks are.

The driving springs as shown by the diagrammatic view are underhung, the firebox being on top of the frames. Liberal sized steps are provided on both the engine and tender, with very conveniently located handholds on both. The arrangement of throttle lever is a little peculiar. As will be seen from the diagrammatic view, there is the usual throttle lever back of the firebox. As the engineer occupies a position on the side, it is desirable to have the lever farther forward. A horizontal shaft, shown in the diagram, is therefore placed on the top of the firebox, which has a vertical arm located in the transverse center of the engine, and is connected with the throttle lever by a rod. On the outer end of the shaft there is a pendent lever, with a cranked handle or the engineer.

The appearance of these engines is very impressive. As shown in the diagram, the centers of the boilers are 107½ inches above the rails. They are of large diameter, so that the body of the machine is high and the Belpaire firebox adds to the massiveness of its appearance. The engines have been doing excellent service and reflect much credit on the designer. As mentioned in our first article, they weigh 134,500 pounds, and carry 185 pounds of steam pressure per square inch.

(To be continued.)



Vauclain Compound Passenger Locomotive for Chicago, Milwaukee & St. Paul Railway.

Vauclain Compound Passenger Engines for the Chicago, Milwaukee & St. Paul Railway.

The Baldwin Locomotive Works have recently delivered to the Chicago, Milwaukee & St. Paul Railway two powerful passenger locomotives designed for service between Chicago and Milwaukee. The road has a number of heavy and fast passenger trains between the two cities, and we believe that these engines are expected to be able to cover the distance of 85 miles in about 1½ hours when hauling these trains, which often comprise ten heavy cars. This does not at first seem to be as remarkable a performance as it really is, but when it is stated that the first four miles out of Chicago is through a thickly populated district and is obstructed by numerous grade crossings, so that 10 minutes are allowed for this distance, it is clear that excellent work must be done for the remainder of the journey.

From the accompanying engraving it will be seen that the engines are four-cylinder Vauclain compounds, and in general arrangement of running gear resemble some other express engines recently built by the Baldwin Works. The engines are remarkable for their great boiler power, there being 2,244.5 square feet of heating surface and 30.2 square feet of grate area in each. The principal dimensions are as follows:

Gage of road	4 feet 8½ inches
Cylinders diameter	H. P. 13 L. P. 22. Stroke 26
Driving wheels	78 inches diameter
Total wheel base	25 feet 6 inches
Rigid " "	13 " 9 "
Driving " "	6 " 9 "
Weight, total	140,700 pounds
" on drivers	71,600 "
" " trailing wheels	29,100 "
" " truck	40,000 "
Boiler diameter	60 inches
Number of tubes	261
Diameter of tubes	2 inches
Length of tubes	15 feet
Fire-box, length	$103\frac{3}{16}$ inches
" width	42⅛ "
" depth	71½ inches front 69 " back
Heating surface, firebox	171 square feet
" " tubes	2,073.5 " "
" " total	2,244.5 " "
Driving wheels, diameter	78 inches
Truck wheels diameter	36 inches
" journals	5½ inches by 10 inches
Trailing wheels, diameter	54 "
" journals	7 inches by 12 "
Tender tank capacity	4,500 gallons
" wheels, diameter	33 inches
journals	4½ inches by 8 "

On July 10, one of these engines (No. 839) made a good run from Chicago to Milwaukee. It pulled train No. 23, which leaves Chicago at 3 p. m. and has a schedule time of 1 hour and 55 minutes. Two stops are made by this train, one at Western Union Junction and the other at National avenue in the outskirts of Milwaukee. On the trip alluded to the train consisted of 14 cars, as follows: Four baggage and express cars, four coaches, four drawing-room cars, and two sleepers. The total weight of the train back of the tender was considerably in excess of 500 tons. Notwithstanding this heavy load the engine made schedule time, and made up five minutes lost at Western Union Junction through some delay with the baggage. At some places a speed of 80 miles per hour was maintained for a number of consecutive miles.

Engine Power and Self-Propelled Road Traffic.

Sir David Solomons has an article in the *Engineer*, under the above caption, in which he gives some figures on the power required in self-propelled road carriages. From his article we take the following:

A vehicle which will travel at a given speed, say of 12 to 14 miles per hour, no matter whether the country be flat or hilly, is a great factor in annihilating space.

Before my steam carriage with the Serpollet boiler was constructed, I was anxious that a series of calculations and experiments should be made in order to be fairly sure, in advance, that the result I sought was likely to be realized. The results are closely in accord with the experiments I made at an earlier date, and it may be of interest to those engaged in the manufacture of these carriages to have some information on the subject. In giving the figures, I take round numbers, which are quite close enough for all practical requirements.

I assume the carriage to weigh 2½ tons when laden, then on a good level road a speed of 7½ miles per hour can be obtained for 2½ horse power, and on a bad level road for 4⅝ horse power. To travel up an incline of 1 in 20 on a good road at the same speed would require 10 horse power, and on an incline of 1 in 10 on a similar road about 19 horse power would be necessary. It will be noticed from these figures that each succeeding horse power necessary is practically double the preceding one. It will also be observed that the increased power required between a level road and an incline of 10 per cent., which is not uncommon in many districts, is practically as 1 to 5.

From these figures it is obvious that in order to travel at so slow a speed as 7½ miles per hour, whether on the level or a hill of 10 per cent. rise, in the case of a carriage weighing 2½ tons, when provisioned and laden, the vehicle must carry an engine capable of giving up to, say, 20 horse power. If a speed of 12½ miles per hour on a good road is sought, nearly 4 horse power is necessary; on a bad road 7⅝ horse power; on a 1 in 20 incline, 16⅝ horse power;

on a 10 per cent. incline, roughly, 30 horse power. For a speed throughout at the rate of 15½ miles per hour on a good level road, about 5 horse power is necessary; on a bad road, 9 horse power; on an incline of 1 in 20, 20 horse power; and for an incline of 10 per cent. rise, nearly 40 horse power.

If the weight of the vehicle when laden was, say, 1 ton; the horse power necessary for similar speeds would be two-fifths of the figures given above. This I mention, because 1 ton is approximately the weight of most petroleum motor driven carriages when laden.

If it now be desired to travel on the level and up hill at an unvarying speed of, say 12 miles per hour, such a carriage should carry an engine capable of giving from 2 horse power up to 12 horse power. Since the majority of the carriages in question are fitted with engines incapable of giving more than 4 horse power, the desired uniform speed of 12 miles per hour will, therefore, be reduced to one-third, viz., four miles per hour where a 10 per cent. incline is reached. This is what they realize in practice, and may be taken as a very good proof that the figures I quote are approximately correct.

The general analysis given above is instructive, for the reason that it teaches two important facts which are essential when a given average speed is required : (1) That no vehicle is of much service for heavy work unless an engine capable of giving out not less than 30-horse power is fitted ; (2) that for light traffic the engine should give not less than 12-horse power for the maximum.

That both these conditions can be fulfilled with steam has been proved, but in the case of petroleum-driven motors I do not think that the result has yet been satisfactorily obtained. To increase the power of the latter form of engine threefold means in practice that its weight would be at least twice as great, and that more water would have to be carried for cooling the cylinder or cylinders, water in all probability being lighter than any form of cooling apparatus to do the equivalent duty. It is, therefore, clear that if the petroleum motor is to be heavier, the first conditions stand altered, and in consequence of the carriage being heavier, the speed will be reduced, or a still larger engine must be carried.

I therefore conclude, in the present state of our knowledge, that if the light petroleum-driven carriage is required to run at an average speed of 12 miles per hour on good and bad roads, where inclines exist up to a 10 per cent. rise, the carriage laden will probably weigh not less than 1½ tons and require a maximum of not less than 18 to 20 horse power.

The *Aluminum World* gives the following rules with regard to obtaining the best castings with aluminium bronze. An essentia point is the special care to be taken not to overheat the metal, for if it be heated to too high a temperature, the aluminium will oxidize, the oxide which is thus formed making the entire casting " dirty " ; the metal will also be spongy from the presence of large amounts of occluded gases. The scum, which floats on top of the melted bronze in the crucible, must be prevented from going into the body of the casting. The greatest trouble in making bronze casting, however, arises from the great shrinkage of the metal, a difficulty which is overcome if the casting have a large sinking head and " risers," it being necessary, however, in many cases to make the sinking head fully as large as the casting.

In the latter part of June the *Lucania*, of the Cunard line, and the American built *St. Paul*, of the American line, made remarkable western trips across the ocean. The *Lucania* averaged 21.37 knots per hour for the entire distance, 2,855 nautical miles, while the *St. Paul* averaged 20.58 knots for the distance covered by it, namely, 3,113 nautical miles. The best day's run of the former was 562 knots, and of the latter 540 knots. These speeds are enormous, being about 28 and 26 statute miles per hour respectively, maintained for 24 hours. The *Lucania* has about 30,000 horse power and the *St. Paul* nearly 22,000. Consequently, with about 40 per cent. more power, the British boat made only about 4 per cent. more speed. Of course the British boat is the larger, but there is not enough difference in tonnage to account for the difference in performance. The greater coal consumption of the Cunarder, amounting in all probability to at least 150 tons per day, and the greater cost of operation attendant on the larger boat, may have their effect in deterring other lines from attempting a speed of 22 knots, though the new North German Lloyd boats are to have a horse power of 28,000.

The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes.*

BY M. L. TOLMER, SUPERINTENDENT OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE AT MOHON (ARDENNES).

The substitution of iron sections for wood in the construction of cars date on the Eastern Railroad of France from the year 1861. From 1861 to 1866 about 1,840 cars, 4.8 metres (15 feet 9 inches) long over the bodies, and designed for the transportation of coal (known as series L) were built with the upperframes,† or frames of the box, of iron. By this innovation the weight of these cars was reduced to 4,300 kilograms (9,460 pounds), while the weight of similar cars of wood was 5,000 kilograms (11,000 pounds).

The endeavor to reduce the dead weight, the difficulty of procuring large and long timbers free from defects, the high price of such timbers and the progress in metallurgy which permitted the production of iron sections of exact dimensions all led to the employment of iron in the construction of rolling stock. It was with such ideas as these that there was built in 1865 the first cars having mixed underframes, that is, frames partly of iron and partly of wood, the sills which the pedestals were attached being of I or channel sections 250 millimetres (9.6 inches) high.

M. Boutard, Engineer of Rolling Stock on the Eastern Railroad, in 1868 designed a car of 10 tons capacity, provided with high sides (for the transportation of coal and coke) of which the underframes and upperframes were entirely of iron. This car, quite remarkable for that period, was made 5.5 metres (18 feet ½ inch) long over the body. It weighed empty only 5,320 kilograms (11,700 pounds), and combined lightness and strength to a greater degree than similar cars with wooden or mixed frames already in existence.

From the beginning of 1869, all the cars of the company have been built with the underframes of iron, and the uncovered freight cars having high sides (series L and H) have had the upperframes of iron also. With the inauguration of these designs the length of the car bodies have increased, until to-day they have attained a length of 7 metres (22 feet 11½ inches) for cars in regular service, while this figure has been exceeded considerably in special cases.

Certain other companies, for various reasons, have gone much further in this direction, and have adopted types of cars in which the entire box or superstructure is of iron. The Eastern Railroad itself possesses 120 cars (series U and Uf) purchased from the Compagnie Léronville-Sedan, which conform to these types, the flooring alone being of wood.

The Eastern Railroad possessed on December 1, 1895, a total of 28,504 cars, as follows:

7,613 cars with underframes and bodies of wood.
1,880 cars with underframes of wood upperframes of iron.
3,249 cars with mixed underframes and upperframes of wood.
1,276 cars with mixed underframes and upperframes of iron.
14,366 cars with iron underframes and of which 3,761 also had iron upperframes.‡
120 cars with iron underframes and entire box of iron.

Without dwelling upon the great progress realized in construction by the employment of metal parts, we will at present discuss the life which it is reasonable to attribute to these cars, and estimate under several conditions varying with the time, the expense involved in their current repairs.

In the study of this question of great interest, which was intrusted to us by M. Salomon, Engineer in Chief of Material and Motive Power of the Eastern Railroad, at least in respect to the rolling stock of that company, we have taken apart and examined, piece by piece, a certain number of cars built in the earlier years. Each piece was weighed, after having the paint and rust removed from its surface by scraping and brushing. Moreover, the exact outlines of the various sections were determined where the wear or loss from rust had been great or was of special interest. The weights obtained have been compared with the weights of the same parts when new, to determine the proportion of metal lost. In making this comparison we have had at our service sections of the same dimensions found in the storehouse.

---

*Translated from the *Revue Generale des Chemins de Fer.*

†All the cars here considered are carried on four wheels and are of a type resembling the flat-bottomed gondola cars in this country. By upperframes is meant the frame or skeleton of the sides and ends which form the box.

‡ Of 4,793 passenger cars owned by the company, 1,183 have wooden underframes, 471 have mixed underframes, and 3,139 have underframes entirely of iron. Of 1,374 cars partly owned by the company, 280 have wooden underframes, and 1,094 have underframes entirely of iron.

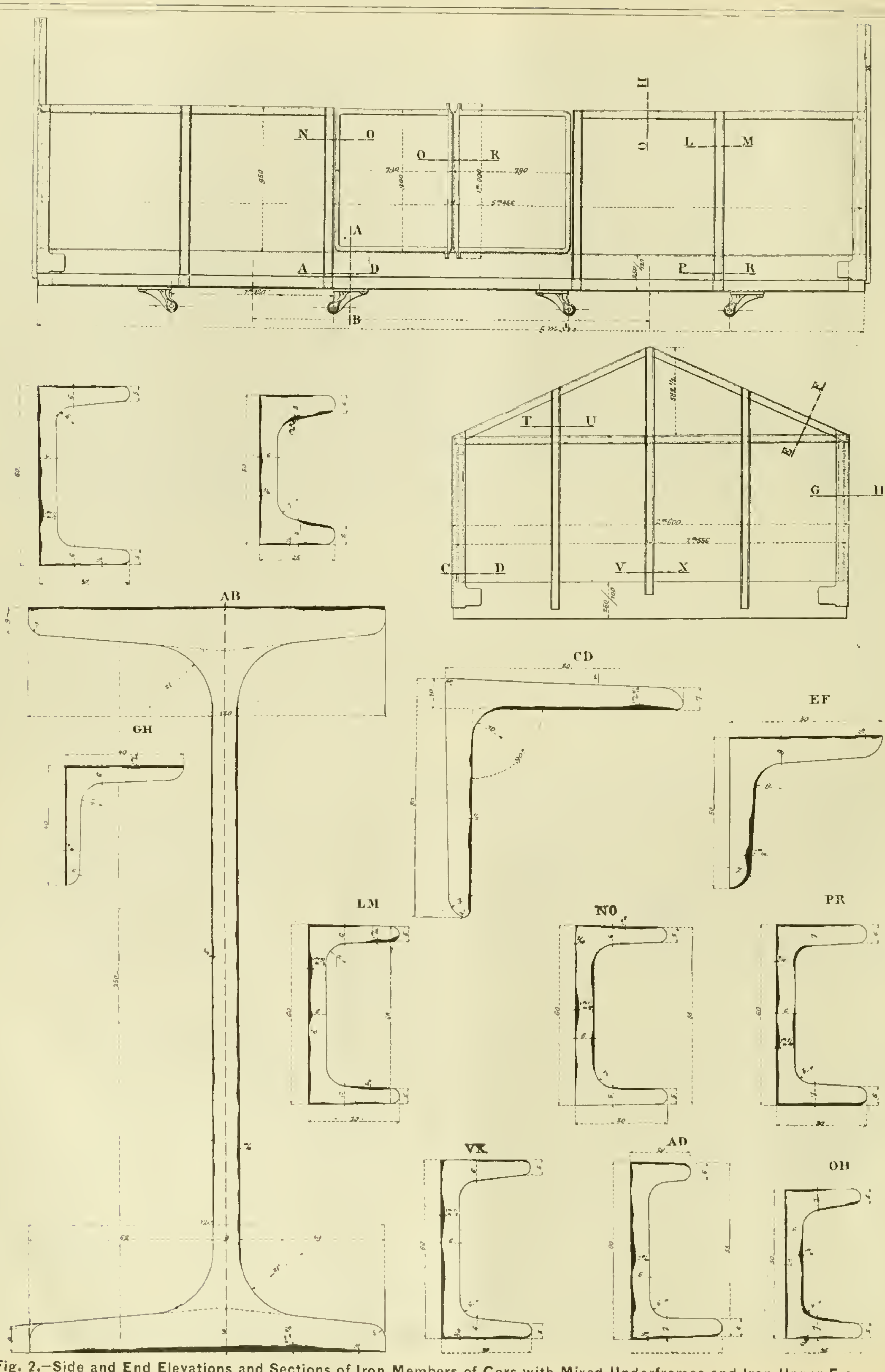


Fig. 2.—Side and End Elevations and Sections of Iron Members of Cars with Mixed Underframes and Iron Upper Frames Built by the Eastern Railroad in France in 1865.

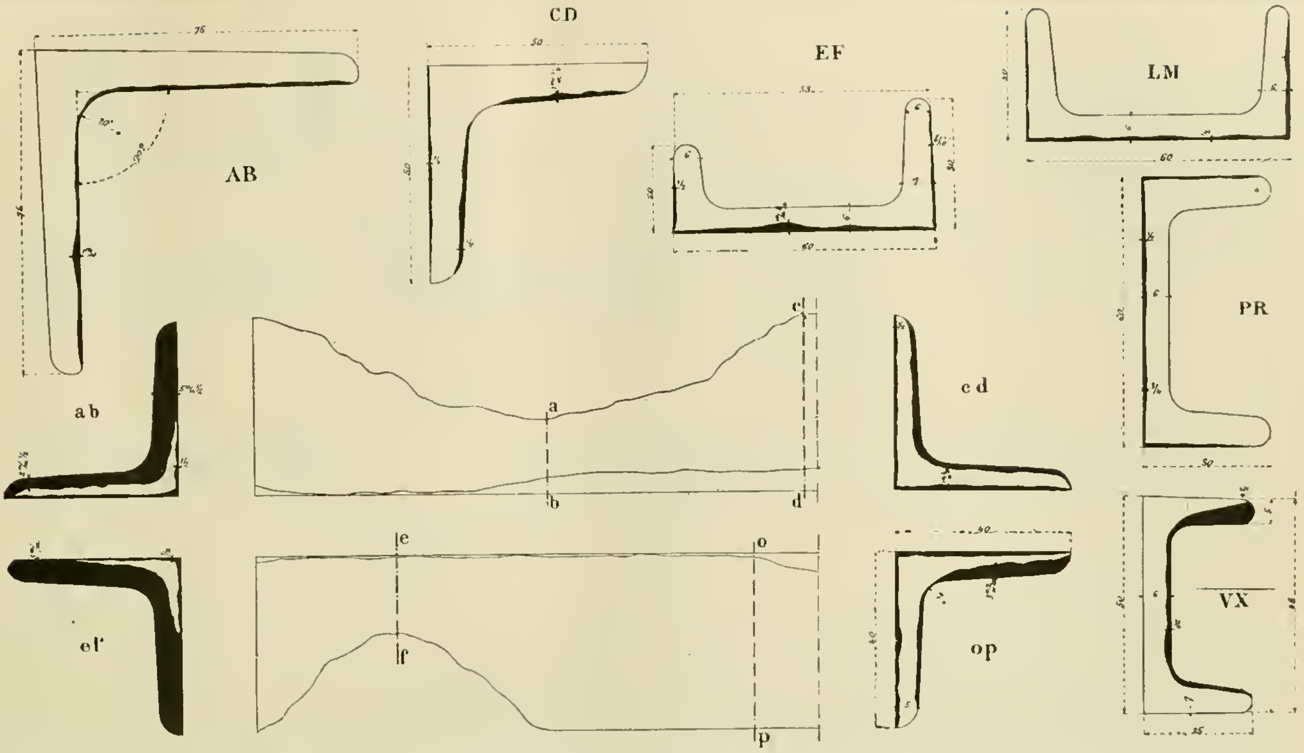


Fig. 1.—Sections Showing Corrosion of Steel Upperframes on Cars Built by the Eastern Railroad of France in 1861.

NOTE.—Ca s were somewhat similar to design shown in Fig. 2, but had wooden underframes. A B is section of outside angle at corner post; a b is a section of the inside angle at corner post; C D is section of angle at top edge of end of box; E F is section of a side post; L M and P R are sections of end posts; and V X is a section of top edge of side of box.

The cars subjected to this examination belonged to the following six types, representative of four distinct epochs in construction:

1st. Cars of series L, constructed in 1861, with underframes of wood, and upperframes of iron.
2d. Cars of series H, constructed in 1865, with mixed underframes, and upperframes of wood;
Cars of series L, constructed in 1865, with mixed underframes, and upperframes of iron.
3d. Cars of series H, constructed in 1869, with iron underframes, and iron upperframes;
Cars of series L, constructed in 1875, with iron underframes, and iron upperframes.
4th. Cars of series U, constructed in 1874, built entirely of iron except the flooring.

All of these cars examined have been selected because they have not at any time been subject to modification or to extensive repairs, and have not had new parts substituted for those entering into the original construction, and because they have not suffered accidental damage more severe than they would receive in ordinary service.

CARS WITH WOODEN UNDERFRAMES AND METAL UPPERFRAMES.

The cars having their underframes of wood and upperframes of iron were built in 1861; they have consequently been in existence about 34 years. Many have already been demolished, the underframes having become useless for further service and the iron upperframes having suffered so much from oxidation as to be beyond repair. We have, in particular, examined car L 28,099, some of whose sections are given in Fig. No. 1. The areas shown in black indicate the metal lost by corrosion.

It is shown by this examination that the oxidation caused a loss of 6.04 per cent. of the weight of the frames. Unfortunately the corrosion occurred principally at certain points that affected greatly the strength of the structure, particularly in the angles girdling the sides and ends at the top and the angles in the interior of the corners, nearly all of which parts at the present time require to be replaced as the cars come into the shops for heavy repairs. The expense under this head amounts to about 25 francs ($5) per car.

Probable Life.—It is admitted that for these cars the metal upperframes in general have no greater life than the principal parts of the wooden underframes. We have no further knowledge that would justify a systematic restoration of this type. By the retention of the best of the iron sections still in service and the use in repairs of those parts still fitted for service, obtained from cars broken up, it has been possible to prolong the existence of a certain portion of the series for a period of half a score of years. Up to that time the cars decayed successively by reason of the general corrosion of the metal upperframes, and of the bad condition of the wood underframes.

To sum up, while the adoption of iron upperframes makes a lighter car than when wood is employed, the life of the car is not materially increased. Its life varies from 30 to 40 years.

CARS WITH MIXED UNDERFRAMES.

We have examined cars with mixed underframes, numbers H 11,921 and H 12,213, having the upper frames of wood, and the cars, L 29,861, L 29,856, and L 30,314, having metal upperframes (Fig. 2). These were constructed in 1865, and are 30 years old.

The Underframes.—The sills of the frames upon examination were found to have lost 3.35 per cent. of their original weight. The loss is from the entire inner faces of the I-beams where the surfaces have seldom been painted, and from the surfaces covered by other parts. It is at the spring suspension attachment to the frame that the corrosion is most easily seen, but at no point has it become so great as to lead one to question the safety of the piece.

Upperframes.—The loss from the members of the iron upper frames of the cars of series L (series H are of wood) is much greater than the loss from the sills, particularly in the case of such parts as are situated inside of the box, or are covered by the wooden flooring. The average loss from rust was 4.32 per cent. In no one part had it become sufficient to require the replacement of the member.

Rivets and Gussets.—The riveting in these cars is of comparatively little importance, as it is employed only in the assembling of the frames to keep the end sills and intermediate crossties square with the longitudinal sills. We estimate the number of rivets in doubtful condition at 15 per cent., due either to the rivets being badly placed at the beginning, the iron being burned or too cold, or because the metal was brittle through bad work or inferior material. In all cases the loss of metal from the heads by corrosion is not serious, and the loosening of the rivets by shocks and vibrations is absolutely imperceptible.

The brackets uniting the intermediate crossties with the longitudinal sills are still in a satisfactory state, but a great number of gussets uniting the end and longitudinal sills had to be replaced repeatedly because of breakage in regular service.

Probable Life of the Cars.—In the cars with mixed underframes it is considered that the iron sills are yet good for a period at least equal to the time they have been in service, which would give them a total life of, approximately, 50 to 60 years. Concerning the metal upperframes of the cars in the series *L*, it is considered, after com

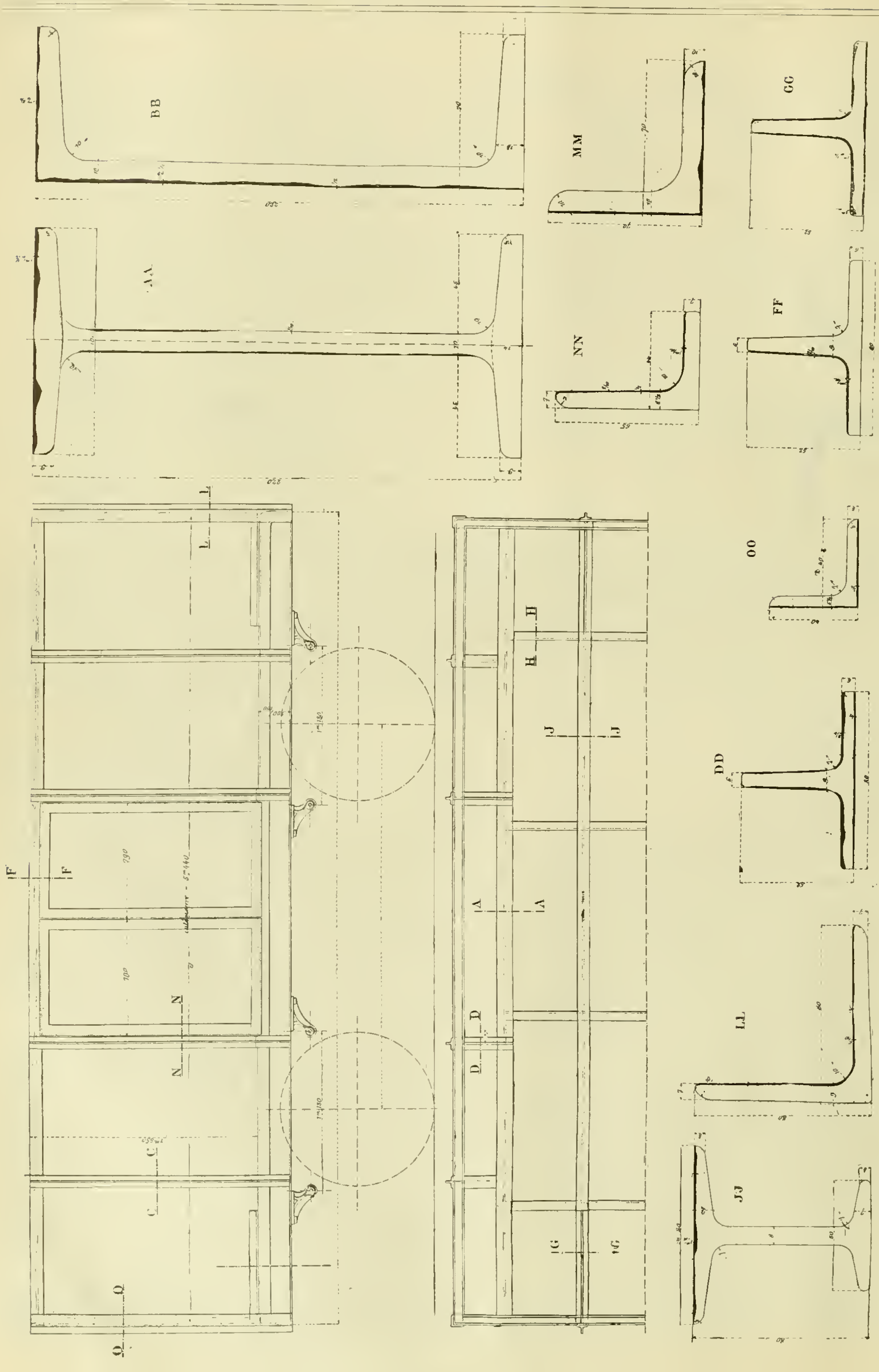


Fig. 3.—Elevation, Half-plan and Sections Showing Corrosion of Iron Members of Cars with Iron Upperframes and Iron Underframes, Built by the Eastern Railroad in France in 1869.

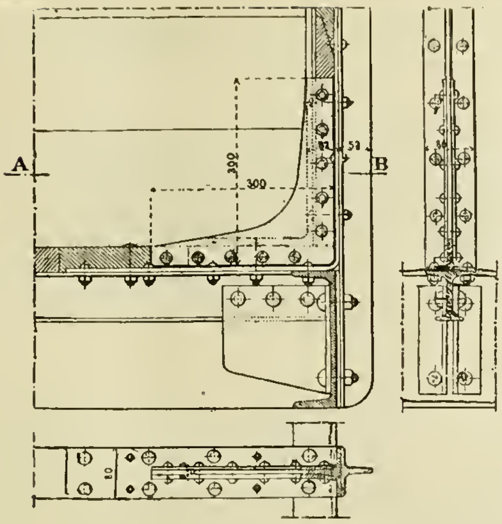


Fig. 5.
Old Construction on Cars Built in 1869.

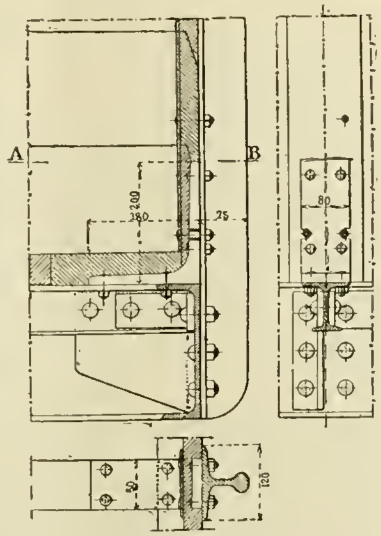


Fig. 6.
New Construction.

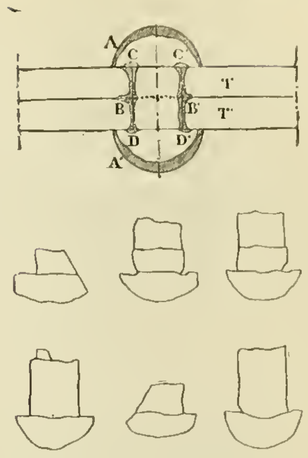


Fig. 7.
Corrosion of Rivets.

parison with similar parts of the cars built in 1861, that in four or five years it will be necessary to commence renewing some of them. By following, in the repair of these upperframes, the same method of procedure as for the cars of the year 1861, the condition of the underframes being first considered, it is believed that by spending the small sum of 25 francs ($5) on them, the box or superstructure of the car will be good for from 10 to 15 years more of service. We estimate that at the end of that period it will be necessary either to make a new box or destroy the car. It will at that time have had a life of from 45 to 50 years, which period can be extended to 55 or 60 years by the expenditure of about 270 francs ($54).

CARS WITH IRON UNDERFRAMES AND IRON UPPERFRAMES.

We have examined cars Nos. H 13,305 and H 13,748 built in 1869 (Fig. 3) and having therefore been in existence 26 years, and the cars L 27,621 and 30,582 built in 1875 and consequently 20 years old.

Underframes.—The loss from the iron members amounted to about 6 per cent. for the materials put in service in 1869 and 3.18 per cent. for those of 1875. It appears again, therefore, that the action of the rust is not proportional to the time, but increases more rapidly than the time. Nevertheless, it is acknowledged that in these particular cases the loss is not yet important enough to call for the replacement of any parts; and that, on the other hand, an important point relative to the losses by corrosion is the fact that in cars of the series H (year 1869) there is one more intermediate crosstie, providing relatively more small iron work on which corrosion can act.

As in the case of the mixed underframes the loss of metal from the sills is all from the interior surfaces and those surfaces covered by other parts, notably at the top of the spring suspension brackets The same observation is true of the end sills.

In respect to the iron floor stringers and the intermediate crossties these are corroded somewhat on all their faces, and in a manner proportionately more important than on the sills. These facts are an evidence of the enormous influence of the paint in preserving the iron parts of the underframes.

The Superstructure or Box.—The loss from the iron upperframes in the series H. type 1869, was about 5 per cent. In this, as in other cases, it is the metal parts inside of the box which have suffered most, particularly the gussets holding up the end posts as shown in Fig. 5. Generally these gusset plates which are only 6 millimeters (about $\frac{5}{16}$ inch) thick are so weakened that their replacement is necessary. We will also, hereafter, substitute for this assemblage of parts, which is somewhat complicated, a design analogous to that of the construction shown in Fig. 6. This modification consists in substituting for a T-iron upright or post one of a rail section and securing it by a forged knee or bracket. In our opinion, when this modification becomes general the design of the upperframe leaves nothing to be desired. The work of changing costs 150 francs ($30) per car.

Rivets, Gussets, etc.—The iron underframes, types 1869 and 1875, it seems to us, should decay first of all about the riveting, although on four cars examined only two rivets were lost, and 10 others were loose in the holes. A separate examination of the rivets show that the corrosion is generally as indicated in the upper part of Fig. 7. One-half of the rivets have lost 15 per cent. in weight, there being a large loss at *BB'*, probably due to the accumulation of moisture between the parts *TT'*.

It is clear that machine riveting, particularly hydraulic riveting, by bringing the plates together with force at the moment of driving the rivet and in making the rivet fill the hole well reduces greatly the chances for rust at *B*, *C* and *D*, but in the old material riveted by hand it is to be feared that in several years the surfaces *CC' DD'* will have continued to corrode, and many rivets will be found loose in their holes, as we have established in a score of cases

The heads *AA* are all more or less eaten, but it does ,not appear that at present they are likely to cause the loss of the rivets.

If it is considered that the oxidation of the rivets is of sufficient importance to cause solicitude, care should be exercised in the building shops in keeping the cupping tools of the riveters in shape, and guarding against the disposition of the men to repair these tools themselves, as they will grind the faces or edges, finally giving forms of rivet heads that are too much flattened.

We conclude from the results of our observations that the rivets in these cars will exhibit the defects enumerated above in the following order :

1st.—Rivets holding together the smaller parts of the upper framing. (Generally speaking these rivets are very strongly attached by corrosion ; many have already been replaced in the course of current repairs and others will be as the cars enter the shops for repairs).

2d.—Rivets in other parts of the upper frames—those which hold together the heavier parts of the frame.

3d.—Inner rivets in the gussets securing the angles of the underframes, and rivets holding the angle iron floor stringers to the intermediate crossties.

4th.—Rivets holding the guard plates, the corner irons—holding the crossties to the sills—and those securing the plates to which the drawgear is attached, etc.

The rivets in the second and third categories will be found in a poor state of preservation; we estimate that it will be necessary to replace regularly 50 per cent of the former and 25 per cent. of the latter in each passage of the cars through the shops for heavy repairs. With this precaution, of which the cost is about 8 francs, ($1.60) per car, the riveting of the iron underframes of these cars will suffer very little from wear and rust for a score of years. The rivets in the fourth category require as yet no attention.

The plate iron gussets have experienced a loss estimated at more than 18 per cent. of their weight. Nevertheless, as they were originally very heavy and the oxidation is chiefly outside the lines of rivets, it is to be presumed that these parts have a life equal to that of the frame as a whole.

Probable Life.—All these precautions will likely contribute to the prolongation, without accidents, of the life of these cars through a period equal to that already passed since their construction, thus assuring them a total existence of about 50 years. It appears certain that this life can be considerably increased by exercising care to prevent the action of rust.

From an examination of cars constructed in later times, it is found that the interior surfaces of the underframes commence to lose their paint at the end of three years of service. It is only then that rust begins to be produced. To avoid the rust, then, the frame

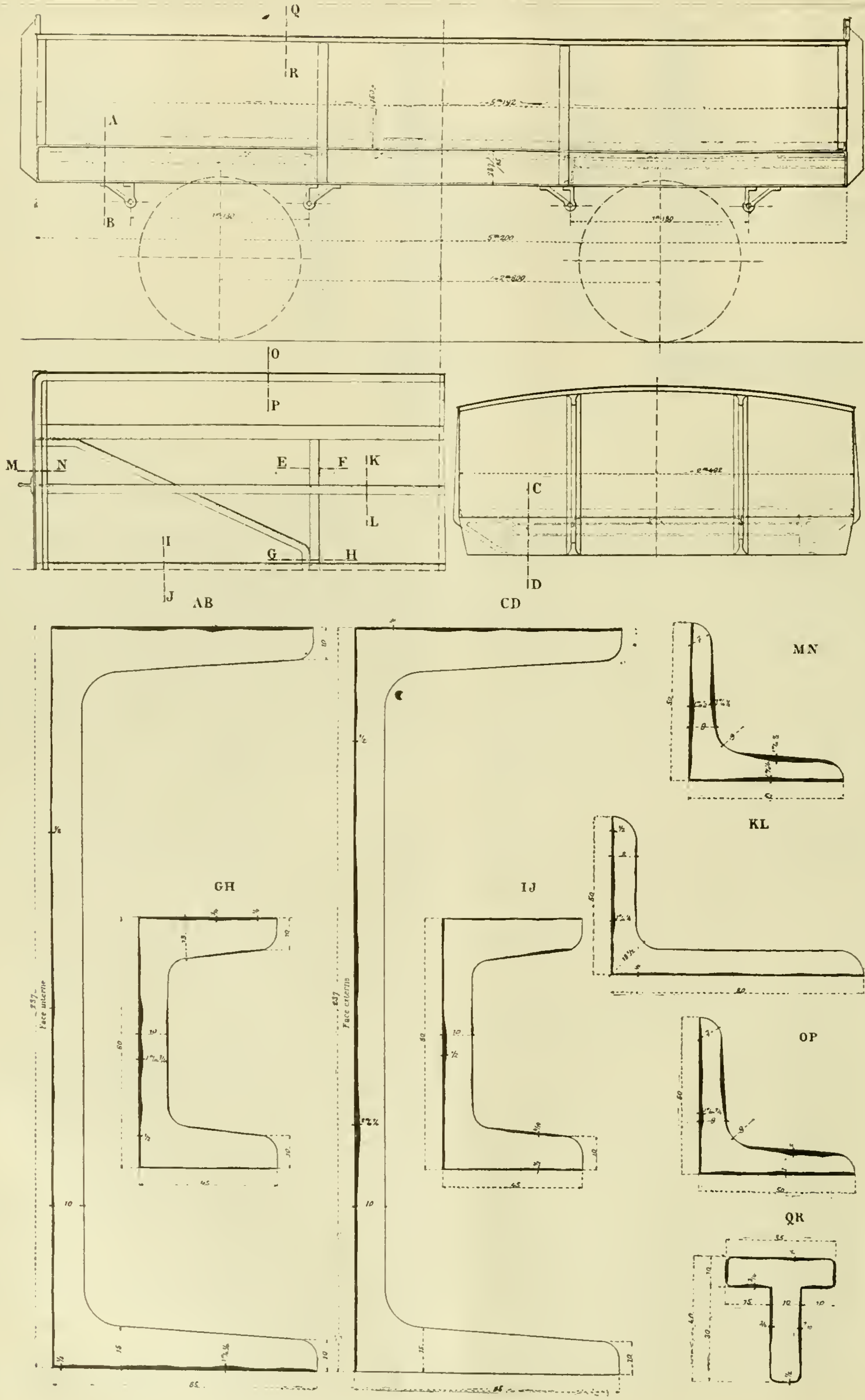


Fig. 4.—Elevation, Quarter Plan, End View and Sections of Members of Cars Built Entirely of Iron, by the Eastern Railway of France in 1874.

should be repainted at least once in three years. This operation, with at least two coats on the iron, will cost about 17 francs ($3.40) including material, labor and all general expenses.

CARS ENTIRELY OF IRON.

We have examined the cars U 25,909 and U 25,962 (Fig. 4), which were built in 1874, and are consequently 21 years old.

Underframes.—The iron sections entering into the construction of the underframes have lost about four per cent. of their weight by oxidation. The corrosion is of much the same nature as in the frames built in 1875 and noted above. The examination of individual sections reveals no cause for immediate apprehension.

Superstructure or Box.—The loss from the iron plates forming the sides and ends of the box is only 1.8 per cent., and is therefore very small. The loss from the special iron sections constituting the upper frames (or frames of the box) is about 12.5 per cent., which is considerable and is explained in part by the fact that the sections are very light. We should probably attribute this to the fact that iron plates cover them and that these plates have a long life. In fact, in the case of the boxes with wooden sides, the friezes being often renewed, the irons are frequently exposed and at such times are painted, which added to their life.

The experience with the cars with boxes wholly of iron has led, then, to the singular conclusion, that the decay of these boxes is due to the destruction (by rust) of the upper frames, and it seems probable that these iron members will have to be replaced from time to time, and this work has already begun after a service of 20 years, and when the plates forming the sides and ends are yet good over all their outer surfaces.

There is a call then in cars of this type, even more than in the cars with wooden sides and ends, to employ in the framework iron sections of large dimensions.

Rivets, Gussets, etc.—The rivets of the underframes of the cars in the series *U* were found in practically the same condition as those the iron frames of the cars built by the railroad company, and require the same care. This cannot be said of the rivets in the superstructure having their heads inside of the box, where they are most strongly attacked by rust; 35 per cent. of these have to be replaced each time the cars undergo heavy repairs.

REMARKS ON ALL TYPES OF CARS.

We have considered only the types of cars designated by the letters *L*, *H* and *U*, which are specially designed for the transportation of coal and coke. All of the other types—covered cars, series *N*, *M*, *NN*, flat cars, series *S*, *I*, *SS*, etc., are also provided with wooden, mixed and iron underframes. The results of the experience with the frames of the cars in the series *H* and *L* will also apply to these others. In regard to the superstructures of other cars we have given no attention to either flat or covered cars, as the material for the covered cars is all wood, and the side-boards of the flat cars of the Eastern Company are also of wood.

SUMMARY.

The present work presents the real difficulties to be encountered in practice, if the cars are to be so constructed as to give equal durability to all their parts.

The loss from the iron sections entering into the construction of the mixed or iron underframes is not yet very great, even for the oldest cars; but it should receive attention if the cars are to remain in service long enough to double the years they have already served. It should be the practice to cleanse and paint every three years, at least, all surfaces of the iron underframes.

The iron upperframes, without doubt, give a lighter construction to the cars, but they do not add much to the life of cars with wooden or mixed underframes. They constitute the parts most susceptible of criticism in cars of the 1869 type with iron underframes. To-day, after 20 years, upperframes require extensive repairs. It is true that the exigencies of the service of the operating department have become very great, but this is an incentive for strengthening the members of the upperframes. It should be remarked that the cars constructed after the first ten years have these upperframes made of iron or steel sections much stronger than in the earlier cars, and consequently present fewer defects than the older materials.

It is to be hoped that the machine riveting, in cases where it is employed, will prolong the life of the rivets.

For the cars 20 years old and riveted by hand, the rivets present visible traces of fatigue, but it is easy to make their life agree with that of the iron sections they hold together, by observing the precaution, each time the cars go to the shops for heavy repairs, of replacing the worst rivets with new ones. The following proportions will serve as a basis for this substitution:

Fifty per cent. of the rivets holding together the smaller parts of the upperframes.

Twenty-five per cent. of the rivets holding together the gussets which strengthen the corners and of those connecting the floor stringers to the various transverse members.

CONCLUSION.

From all the preceding, it follows that in continuing to apply to the iron freight cars the preservative measures indicated above, which will serve to improve their condition, the Eastern Railroad of France has computed, for the cars of the old types and for the new ones, lives respectively of at least 50 and 60 years.

Air and Gas Compressors as Manufacturered by The Norwalk Iron Works Company.

The present is a time of general interest in the storing and transmission of power, and the two great agents utilized for this purpose, compressed air and electricity, are attracting almost universal attention and study in the engineering and railroad world. The more careful and intelligent study thus directed to compressed air is undoubtedly responsible for much of the phenomenal increase in its use and the variety of the methods found for successfully employing it. As the problems associated with its economical compression, transmission and use are better understood and are satisfactorily solved, new adaptations for it are discovered, old uses are extended and abandoned plans revived and carried to successful conclusions. Furthermore, the great advances in general engineering have brought to the front new and heretofore unheard of conditions in certain industries, to meet which the modern high-grade compressor has been and is being extensively used. If anything more is needed to explain the increasing favor with which compressed air is viewed in the last few years it may be attributed to the perfection to which compressors have been brought by the manufacturers, though it must be stated in this connection that the latter have always led the way and been in advance of the needs of their customers.

Prominent among the builders of compressors in this country is the Norwalk Iron Works Company, of South Norwalk, Conn., who have been identified for more than a quarter of a century with nearly every important step in the improvements by which the inefficient single cylinder "wet" compressor of 30 years ago, built only for low pressures, has been developed into the excellent compound or three stage machine of to-day, adapted for pressures ranging as high as 5,000 pounds per square inch. This company was established in 1868. At that time the building of the Earle water pumps was the chief business of the plant, but a few years after the organization Mr. Ebenzer Hill, the present General Manager, became associated with the company, and he, realizing the importance of the field for compressed air and the great opportunity for improvement in compressors, directed the energies of the concern into these new channels. The success of the enterprise was so great that the construction of water pumps was abandoned long ago and for years compressors for air and gas have been the sole output of the company.

At that time air compression was in its infancy. As far as known there were no compound air compressors in use in this country, and it is said that the only one of that type running in Europe was an experimental one. Even the earliest patterns of the Norwalk company were what was known as "wet compressors" from the fact that water was used in direct contact with the air in the air cylinder to cool it during compression. But when their efforts were concentrated upon the production of compressors that were correct both in theory and in practical results, their designs were characterized by improvements on the current practice of the day, which contributed much to the high reputation they now hold. We have not the space to describe these in detail, but it is interesting to note that the concern was the first in this country to use compound or two-stage air compression and also the first to employ mechanically-actuated valves on the intake cylinders. They were also the leaders in the movement toward higher pressures, the first to make a com-

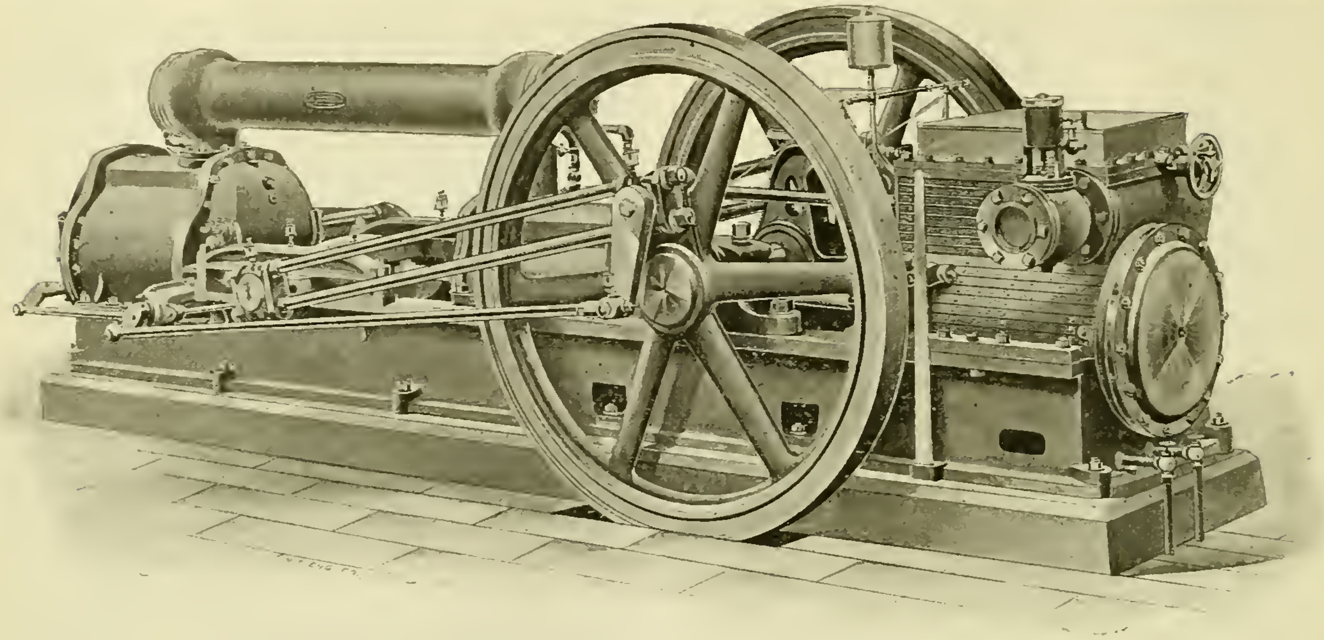


Fig. 1.—Norwalk Standard Steam Actuated Air Compressor.

mercial machine for liquifying carbonic acid gas, and to install a large plant for compressing natural gas. Such an enviable record of progress in the adoption of advanced principles and details of construction has naturally brought to the company much special work, until at the present day it is hard to say whether they are better known through their standard types of compressors or the special ones designed and built by them for unusual lines of work. Among the latter might be mentioned the air compressors for furnishing compressed air to operate the pneumatic dynamite guns of the U. S. Cruiser *Vesuvius*, which were designed to furnish air at 5,000 pounds pressure. They have also supplied the government with the compressors for the new

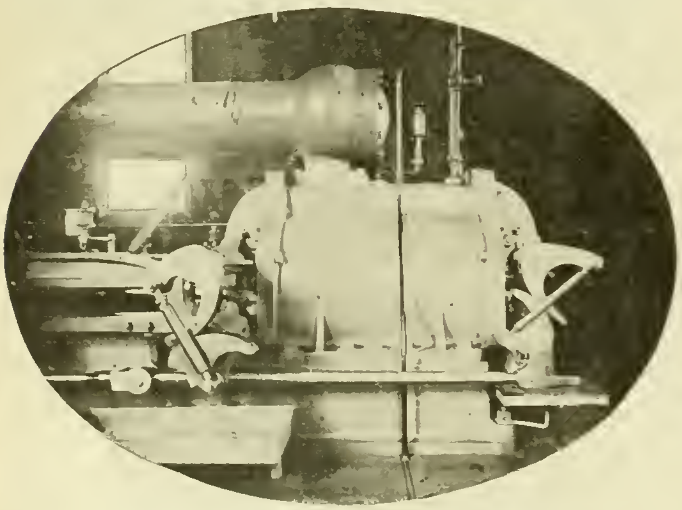


Fig. 2.—Valve Gear on Intake Cylinder.

monitor *Terror* on which air is used for raising ammunition, moving turrets, etc. Other special uses, such as for disappearing gun carriages, compressing hydrogen to 2,000 pounds pressure, the compression of illuminating gas for storage, etc., might be noted, but it will suffice to say that the company has been and is now ready to undertake any special work involving any pressure that can be successfully utilized after leaving the compressor.

While much of this special work carried on by the company would be of great interest to our readers, the limits of our space compels us to be content with a reference chiefly to their standard types. The first of these to which we would call attention is their standard steam actuated compound air compressor shown in Figs. 1 and 2.

In this, as in all other compressors built by the company, the machine is self-contained, all the parts being mounted upon one massive bed-plate, thus avoiding out-board bearings and expensive foundations, and assuring perfect alignment. The air and steam cylinders are in line, the forces being transmitted in a direct line from piston to piston, and the steam cylinder with its high temperatures is as far removed from the intake cylinder as possible. Of course, the steam cylinder and valves can be of any good design, but in all their regular work the company use the Meyer valve gear, with cut-off valves riding on top of the main valve. The mechanism of this gear has recently been greatly simplified, and is now constructed in a manner shown most clearly in Fig. 3, which is a sectional view of a compressor similar to the one in Figs. 1 and 2, except that the steam end is compounded also. Only one larger rocker is used instead of the two formerly employed and the eccentrics are likewise reduced in number. It will be seen that the eccentric is connected to the one rocker, and through it drives the main valve, while by a large "horn" or extension of the eccentric strap the cut-off valve is driven direct. The cut-off on the high-pressure cylinder can be adjusted while the compressor is runing by means of the hand wheel on the extension of the valve rod.

Before leaving Fig. 3 we would state that in compressors having the steam end compounded, the pistons and cylinder heads are so arranged that both of the former can be removed through the low-pressure cylinder. This cylinder does not have to be removed to get at the interior of the high-pressure cylinder. By an ingenious arrangement one gland and packing makes the piston rod steam-tight between the two cylinders.

Turning from the steam end we find the intake and high-pressure air cylinders are in line, with the crosshead between them. This crosshead is a wide one with pins at its ends for the connecting rods that lead to the cranks on the fly-wheel shaft. The piston rods are not connected directly to the crosshead, but are both keyed to a block held in the crosshead by the vertical pin shown in Fig. 3. This permits the crosshead to swivel slightly and thus adjust itself to the length of the connecting rods without straining the piston rods. There is also a slight vertical adjustment provided by means of this same block to compensate for the wearing down of the crosshead and guides.

In a steam cylinder using steam expansively, the greatest force is exerted during the early part of the stroke, while in an air compressing cylinder the power required is largely in the second half. Instead of providing heavy fly-wheels to absorb and give out power in different parts of the stroke, the inertia of the reciprocating parts is utilized for this purpose. The piston rods

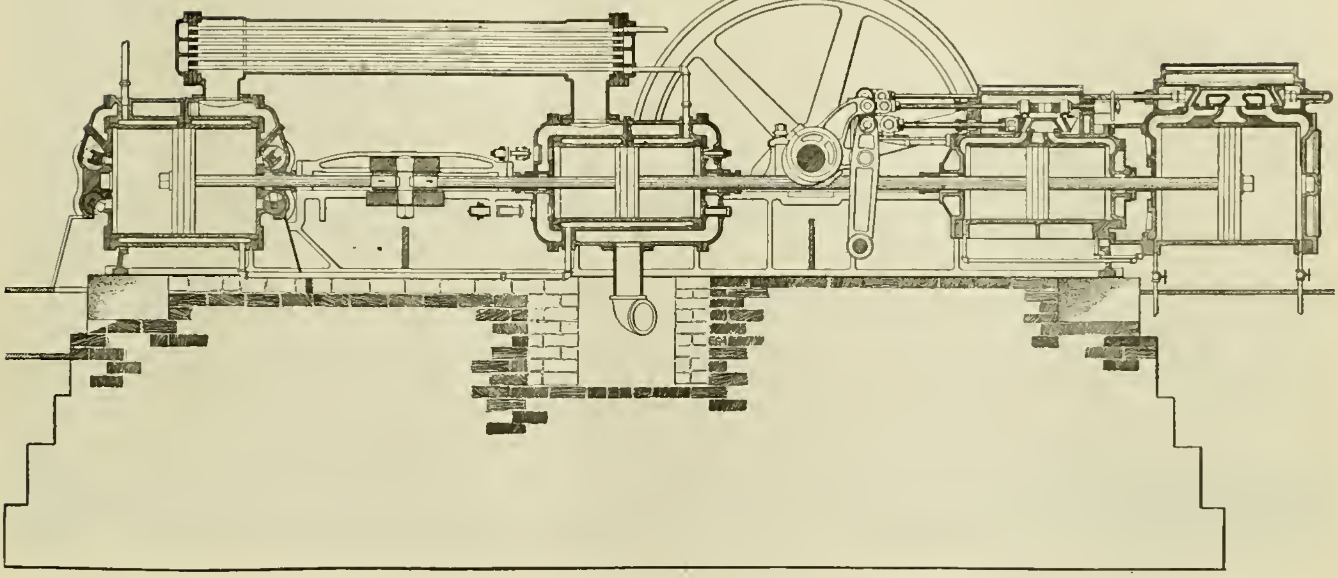


Fig. 3.—Sectional View of Norwalk Compound Air Compressor Driven by a Compound Steam Engine.

and crosshead represent in the aggregate considerable weight, so that it requires most of the power of the steam over and above the air resistance at the beginning of the stroke to start them forward at the required speed. At the end of the stroke, when the steam has become weak by expansion, the power stored up in the momentum of these reciprocating parts is given out in useful work, and the parts are brought to a state of rest by expending their force upon the air in the compressing cylinders. The weight of these parts is purposely made sufficient to give the desired result, consequently the flywheels can be made comparatively light and there are no heavy strains to be transmitted between them and the pistons.

The valves on the inlet cylinder are of the Corliss type, and it will be seen that both inlet and discharge valves are mechanically actuated. The selection of inlet valves of this type was made after a careful investigation of all other forms. Poppet valves are a source of loss from their resistance to opening. It has been found that to make poppet valves operative at all reasonable speeds and conditions, the springs on them must have a force equal to at least eight ounces of air pressure per square inch of valve area. Small as is this pressure, it considerably reduces the amount of air taken in at each stroke, compels the compressor to be run at a higher speed to deliver a given quantity of air, and altogether causes a loss which is not less than 4.8 per cent. and may be more if the conditions are unfavorable. Furthermore, these Corliss valves permit the air to enter the cylinder in large streams and reduce to a minimum the heating of the air from passing over heated metallic surfaces. To further insure the entrance of cool air at the intake cylinder, it is recommended that the air be taken from a cool place outside of the engine-room and led to these valves through wooden conduits, for the attachment of which to the cylinder heads provision has been made. As showing the importance of cool air for compression we present the following table, in which is tabulated the discharge of a com-

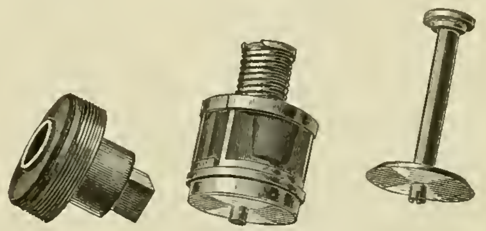


Fig. 4.—Norwalk Poppet Valves.

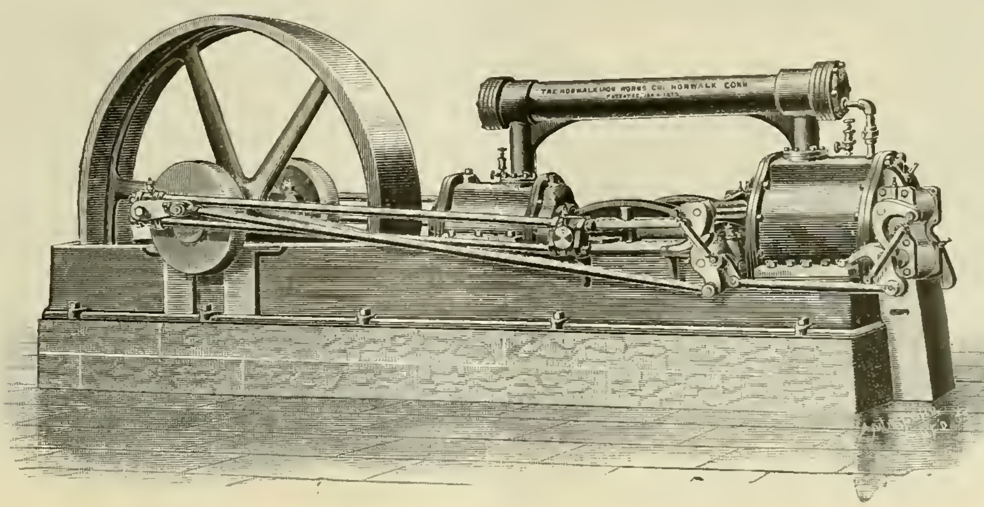


Fig. 5.—Norwalk Belt-Driven Compressor.

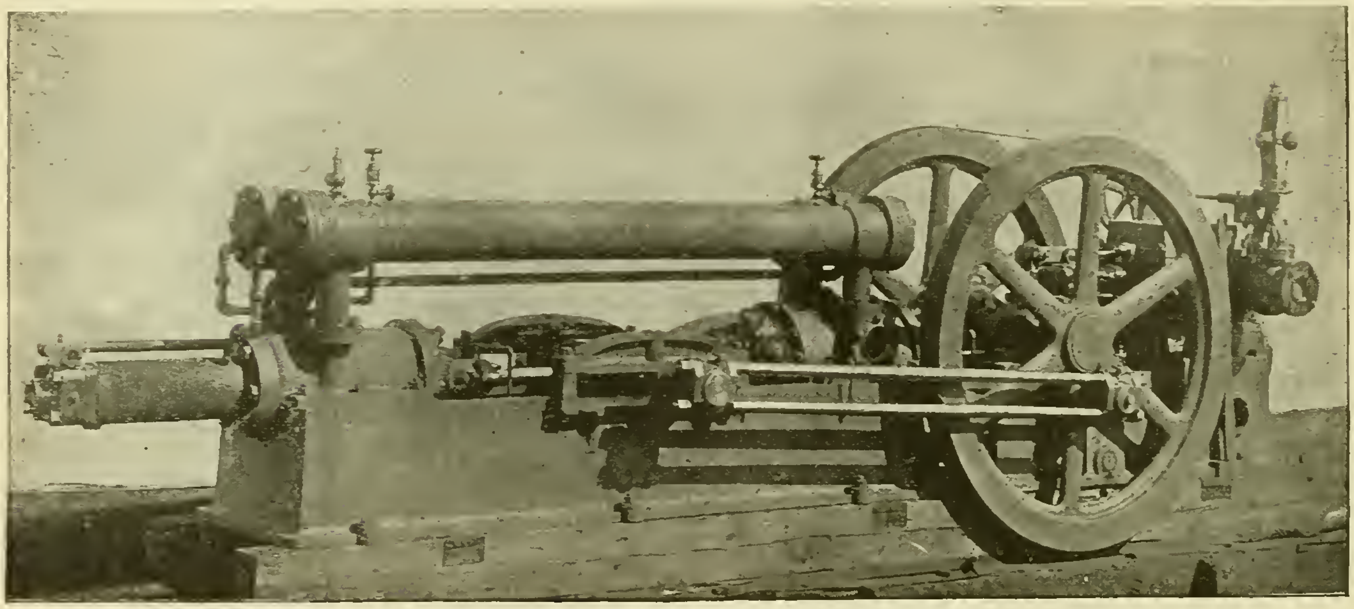


Fig. 6.—Norwalk Compressor for Carbonic Acid Gas.

pressor having an intake capacity of 1,000 cubic feet per minute, for several different temperatures at the intake:

Temperature of intake air.	Volume taken into compressor.	Volume discharged if measured at 62 degrees and atmospheric pressure.
0	1,000 cubic feet.	1,135 cubic feet.
32	1,000 "	1,060 "
62	1,000 "	1,000 "
75	1,900 "	975 "
80	1,000 "	966 "
90	1,000 "	949 "
100	1,000 "	932 "
110	1,000 "	916 "

The above tabulated gains and losses are due to changes in temperature only and have no bearing whatever upon the power needed to work the compressor. The temperature of the intake air does not change the power needed to operate the machine. The resulting efficiency is changed as above shown.

In a compound or two-stage compressor the point at which the discharge valves of the first cylinder should open is fixed by the ratio between the cylinder volumes, and advantage is taken of this fact to give such valves a positive motion. The valve mechanism on this cylinder of the Norwalk air compressor is ingenious. It can be seen best in Fig. 2. The intake valves are driven direct by a connection to a return crank on each end of the fly-wheel shaft, and the discharge valves are opened by means of peculiar shaped cams on the stems of the inlet and discharge valves. These cams allow the discharge valves to stand still during a large part of the stroke and at a time when the pressure in the cylinder is much less than that on the other side of the valve, and then they rapidly open the valves when the air in the cylinder has about reached delivery pressure and the valves are almost in perfect balance. This reduces to a minimum the wear on the valves and valve mechanism and reduces greatly the power required to operate them. The discharge valves are closed by the spring connection between the cams.

The air after passing through the intercooler is admitted into the second cylinder by poppet valves. These and the outlet valves of the same type are placed in an accessible position in the cylinder heads, and are carefully designed. The valve, valve

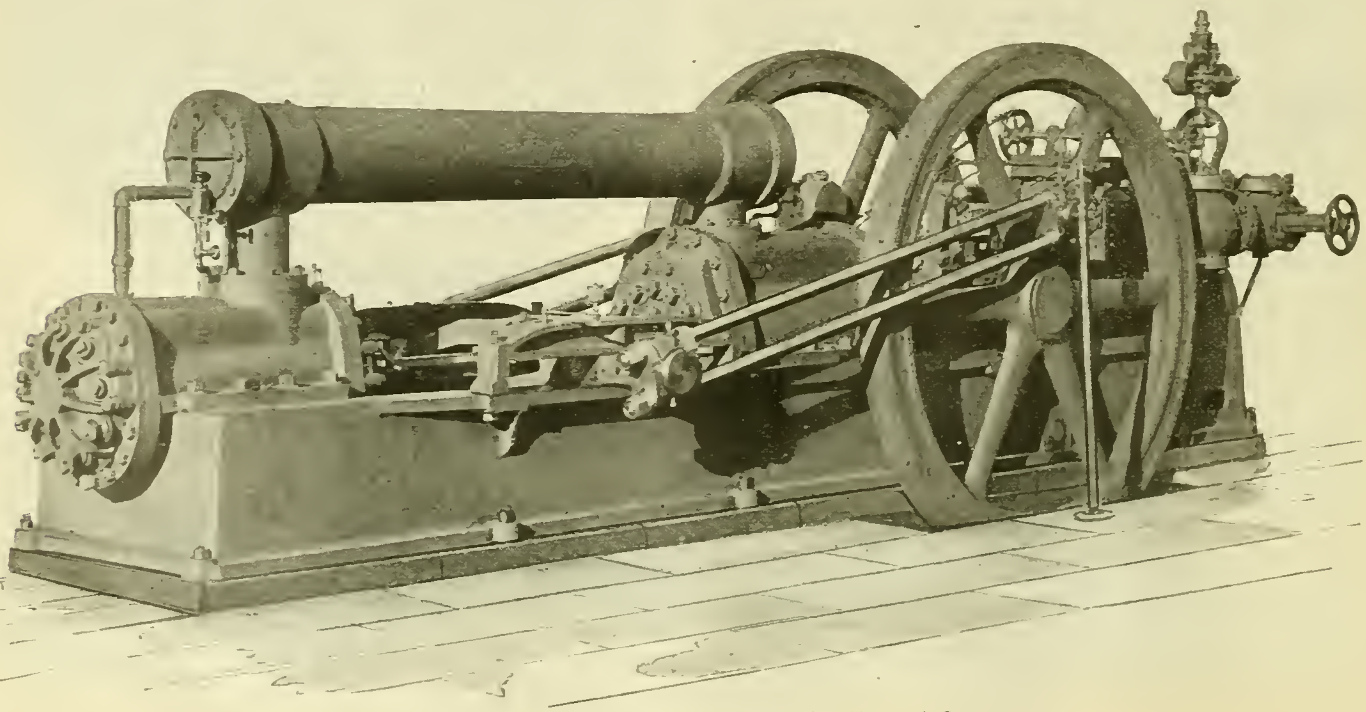


Fig. 7.—Norwalk Compound Compressor for Natural Gas.

stem and head are all forged in one piece, as shown in Fig. 4, so that there are no stems, nuts or split pins to get loose. To permit of this construction, the guide for the stem is made in halves and secured by the seat itself, while the spring is turned into proper position under the head in much the same fashion as a corkscrew is worked, the wire of the spring passing through the small score in the head of the valve seen in the middle view in Fig. 4. The neatness of the arrangement has to be seen to be fully appreciated. This same valve is used in the company's gas machines.

The arrangements for cooling the air are deserving of attention. These consist of jackets on both cylinders and an efficient intercooler. The importance of proper cooling can be better realized when we consider the heat of compression. The extent of this for ordinary pressures can be seen from the following statement of the final temperatures of dry air compressed without any cooling whatever:

		Degrees.	Degrees.
Temperature of air before compression.		60	90
	Pounds.		
Temperature of air compressed to....	15	177	212
" " " "	30	255	291
" " " "	45	317	362
" " " "	60	369	417
" " " "	75	416	465
" " " "	90	455	507
" " " "	105	490	545
" " " "	120	524	580

Perhaps the part this heating plays in work of compression will be better understood from a practical example. Air compressed to 5 atmospheres, or 60 pounds pressure on the ordinary gage, in a compressor without cooling arrangements, would be raised in temperature from 62 degrees to 373 degrees Fahrenheit. Assume that the amount of air is such that it requires an engine of 100 horse-power to do the work. If now a *perfect cooling* apparatus be added to the compressor, the power required would be reduced from 100 down to 78.4 horse-power. In other words the value of a perfect cooling apparatus to that compressor would be 21.6 horse-power. So much cooling cannot be obtained from a single cylinder jacket. In a compound compressor doing the same work the temperature of the air on leaving the first cylinder would be 199 degrees, if the cylinder had no jacket. All this heat above the atmospheric temperature can be taken out in the intercooler. By thus cooling the air the original 100 horse-power required will be reduced to 88.1 horse-power. But we have seen that by perfect cooling another gain of 9.7 horse-power is possible. To effect this a water jacket is put on each of the two air cylinders. In this manner a large part of the gain from cooling is made sure by using an intercooler, and of the remaining gain which is theoretically possible, as much as possible is realized by the use of cylinder jackets.

In the Norwalk compressor the jackets are formed by bushing the cylinders, the main casting being so formed as to leave an annular space around the bushing when the latter is in place. This is a more reliable construction than casting the cylinder all in one piece, as there is no danger from misplaced cores. It also permits the use of a harder and better wearing material in the bushing, and this opportunity is not neglected by the company. The intercooler is the cylindrical chamber mounted on top of the air cylinders and is made of ample volume to give time for complete cooling. The cooling water circulates through numerous pipes to pass which the air must be divided into many small streams.

As already stated, the company are firm advocates of the compound compression, and were the first to employ it in this country. The reasons for their practice have been given in the foregoing, where the gain in efficient cooling was illustrated. Such cooling cannot be effected in a single cylinder by means of one water jacket. Furthermore, there is more uniform resistance throughout the stroke in two-stage than in single cylinder compression. At the same time they build many single compressors for such work as they are adapted to.

We have thus far confined our attention to steam actuated air compressors with either single or compound steam cylinders according to the steam pressure available. The company also build belt driven compressors of the type shown in Fig. 5, in which all the economies at the air cylinders are realized as fully as in the machines already described. For utilizing water power a similar compressor is built in which a Pelton or other water wheel takes the place of the belt wheel shown.

Mention has already been made of the compressors built for compressing and liquifying carbonic acid gas. One of these machines is shown in Fig. 6. The gas first enters the large cylinder through the opening shown, and after compression passes through one of the two intercoolers, thence into the second cylinder, next into the other intercooler, and then into the small cylinder to the extreme left. The first cylinder is double-acting and the others single. The pressure required for liquefaction is of course dependent on the temperature and is in usual practice about 1,200 pounds. The cylinder head on the last cylinder is made of forged steel, and it is found that cast metals are too porous for the pressure. The air cylinders cannot be lubricated with oil because the gas must not be contaminated in the least, and special devices are resorted to for producing frictionless movement.

In Fig. 7 we give a view of one of several compound compressors built for compressing natural gas for the city of Tiffin, O. Each of these compressors is capable of delivering 5,000,000 cubic feet of gas per day through 80,000 feet of 8-inch pipe. These machines differ slightly from the company's regular design of compound compressors in having the large intake cylinder, which is subjected to the lightest pressure, in the middle of the machine. This was done in order that the second or high-pressure cylinder could be thrown out of gear until the changing condition of the field required its use.

One of the largest natural gas pump installations supplied by the company is at Greentown, Ind., where the compressors send the gas to Chicago, 116 miles, through two lines of 8 inch pipe. Last winter the plants equipped with Norwalk compressors averaged a delivery of 100,000,000 cubic feet per day. In some of these natural gas plants the conditions are such that single cylinder compressers are best suited to the requirements and the company has installed a number of these machines at various places.

Several railroads have used ordinary illuminating gas for car lighting and in such cases have needed compressors for that gas. The Pennsylvania Railroad and the Philadelphia & Reading Railroad are using Norwalk compressors for this purpose. The Pennsylvania Railroad has all told 21 Norwalk compressors in service.

There is an attraction about large machinery that captivates many, but this company, though prepared to build compressors of almost any size, do not generally advocate anything larger than 32 inches by 36 inches, believing that in the average large plant it is wiser to adopt approximately that size for each unit and increase the number of units until the desired total capacity is obtained. The workmanship entering into the Norwalk compressors is in keeping with their excellence of design, and whenever the company is acquainted with the exact needs of a customer, a compressor is built which exactly fits those requirements. In conclusion, we would say that those who want to know more about Norwalk compressors or the general principles underlying air and gas compression, should write for one of the company's catalogues. This book is almost a scientific treatise on compressed air, so full is it of valuable information on this subject.

According to the *Railway Age and Northwestern Railroader* the new railroad construction for the first six months of this year is 717 miles, as against 622 miles for the same period in 1895, 495 in 1894, 1,025 in 1893, 1,284 in 1892, 1,704 in 1891, and 2,055 miles in the first half of 1890.

The big steamer building at the Vulcan yard, Stettin, Germany, for the North German Lloyd Company, and which is to compete with the famous Cunarders *Campania* and *Lucania*, will be 625 feet long, 66 feet beam, and 43 feet deep, and her engines will develop 28,000 horse power. A similar ship is also being built at the works of Mr. Scichan at Dantzic. Another of the big German shipping corporations, the Hamburg-American Company, is having built at Harland & Wolff's yard, Belfast, Ireland, a steamer that will be the biggest freight carrier in the world. Her dead weight will be over 12,000 tons and her dimensions are 560 feet long, 62 feet beam and 41 feet deep.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING......................................NEW YORK.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

AUGUST, 1896.

Subscription.—$2.00 *a year for the United States and Canada ;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

The June number of the AMERICAN ENGINEER, CAR BUILDER AND RAILWAY JOURNAL, contained the first of several articles on the Altoona shops of the Pennsylvania Railroad. The convention held in Saratoga in June supplied so much material for the July number of the paper that the second article on Altoona was omitted from that number and now appears in this one. The points of interest which may be observed in Altoona are almost limitless, and the series of articles might be continued indefinitely. The article in this number will be succeeded by several others.

There is hardly such a thing as absolutely pure water obtainable for feeding steam boilers, and as the concensus of opinion seems to be that it is not fit for use in boilers anyway, it is probably fortunate that it is so rare. Apparently pure feed water is found to corrode sheets and flues for some reason not quite clear, and the thinnest of lime scale is found to protect the surfaces from this action. Hence, while very impure waters are to be avoided and the formation of scale reduced to a minimum, feed waters being purified if the conditions are serious enough to warrant the cost of the process, information at present available points to the fact that it is not necessary or even advisable to seek a water absolutely pure or to remove the last grain of lime by a purifying process.

The heating of buildings by means of the waste heat of a steam plant is one of the favorite ways of utilizing heat that would otherwise be a total loss. This is usually done by a use of the exhaust steam from the engine when it is non-condensing, but there was recently published the description of a plant in which the heat is abstracted from the water discharged from the hot well of a condensing engine, and employed to raise the temperature of the air in a hot-blast system, while the air currents generated by the flywheel of the engine are utilized to force the hot air through the ducts. In the case of mills the engines are so large in proportion to the buildings they serve that the heat available is sufficient for the purpose, and in many manufacturing establishments this condition will also obtain. Where such is the case, the system appears to have advantages as the larger heating surface required in the heaters, with its attendant cost and greater space occupied, will be more than offset by the smaller consumption of power.

The tornado at St. Louis has raised an interesting question regarding the limits of responsibility under the Master Car Builders' rules of interchange. These rules say that cars must be returned in as good running order as when received, and the various roads signing the code have agreed to do this. But when property is destroyed by what is in legal phraseology termed an "act of God" the courts will not compel the payment of damages. Some of the roads entering St. Louis were willing to repair at their own cost foreign cars on their tracks damaged by the tornado, while others refused to do so. Some of those refusing did so on the ground that while they might be willing to pay the costs in this case if others signing the code of rules would do likewise in the future, there was no guarantee that such costs could be collected in this or in future cases, nor was there any redress obtainable by taking a future case into the courts. In other words, while the framers of the code of rules might not have so meant it, these rules go further than does the law and involve obligations not recognized in the courts ; hence a settlement of this case under the rules would not be fair to the parties interested unless they were assured that in the future the rules would not be repudiated and the protection of the courts sought by those on whom the obligations would fall. There was to be a meeting held in July of those interested at St. Louis to decide upon the course to be pursued, but at this writing we have not learned the results of the conference.

That oil and gas engines are certain to claim part of the field now occupied by the steam engine is susceptible of new proof almost daily. The advantage of economy in small powers, or, in fact, in all powers in which they are as yet built, is with the gas and oil engines, and in many applications the less bulky fuel, the absence of ash, the greater quickness with which the gas engine can be started, the fact that there is no boiler requiring attendance either while the engine is running or after it is shut down, are all in their favor. One of the latest and most novel applications of the oil engine is on one of the lightships of the United States Government. Here it is made to run an air compressor to supply air for the large whistle used as an audible signal in foggy weather, and one of its great merits in this case is in the fact that it can be started at once when a fog approaches, while with the steam engine there was a boiler to be fired up before power was available. Railroads are also finding a use for these engines at isolated water stations, where a great saving in attendance is found. In fact, wherever the service is intermittent in character the gas and oil engines are doubly advantageous. In many cases, however, where a regular service is desired, the gas engine holds its own and asks no favors of the steam-engine. Unfortunately gas engines have in the past been expensive in the matter of first cost, even costing as much as a steam-engine and boiler of the same power, but the cost is coming down and with the increased demand for them there are opportunities to still further reduce their cost. When this has been accomplished to a sufficient extent the steam-engine will be supplanted to a greater degree than at present.

STEEL UNDERFRAMES FOR FREIGHT CARS.

If we read the signs of the times rightly, the substitution of steel for wood in the construction of freight cars, particularly in their underframes, will make material progress in the near future. The reduced cost of steel and the increasing capacity of cars are both favorable to the change, and steel is being considered by enterprising railroad officials; there is at present a better prospect for a thorough trial of the metal construction than at any time in the past. It is hardly to be expected, however, that great numbers of steel cars will be built immediately, or that the experiences of the near future will be limited to a few designs only. The practical experience of the past has not been such as to converge opinion in favor of any one type; on the contrary, it has left the field open to the invasion of any meritorious design. This condition of affairs is most favorable to those who have special or patented constructions to present to railroad officials, but it is puzzling to the latter, as it is difficult to select from those available a design that shall be put to the test of regular service, without some practical data as a guide in making the selection—data which is not at hand and cannot be obtained by a brief test of a sample car. Designs must be chosen, therefore, by the best judgment that can be exercised without the aid of such data.

Among those who have carefully considered the problems of steel-car construction the question which presents itself for solution is not how the car shall be made to carry a certain load, but rather what are the essential features of a design that shall embody the minimum of weight with the maximum of durability under the action of corrosion, the shocks and complex strains of service and the occasional damage from wrecks, and which shall at the same time be easy to repair when repairs are needed? In other words, the building of steel cars, or cars with steel underframes, is a matter of cost—not the first cost only, but the total cost during the life of the cars. Hence those who contemplate giving them a trial, while not unmindful of the first cost, are naturally desirous that the design selected by them shall ultimately yield the most satisfactory answers to such questions as How long will the cars last? What will it cost to maintain them? How will they go through wrecks? Will bolts and rivets get loose and cause trouble and expense? How can corrosion best be prevented and its effects minimized? While the answers to these questions cannot be drawn from present experience in this country we think there is every reason to believe that when the answers are forthcoming they will be decidedly favorable to the cars with well-designed steel underframes.

As we have not any extensive experience in America on which to draw at this time, our readers will doubtless be interested in an article on another page of this issue, in which is related an experience of 35 years with iron and steel in car construction on the Eastern Railway of France. The freight cars in use on that road are small in comparison with American cars; they are carried on four wheels and are undoubtedly subjected to less rough usage than our cars, and yet there is much valuable experience there related, which will be a help to officials here in deciding upon designs for their cars. Briefly stated, the experience of the Eastern Railway is that while wooden underframes have a life of from 25 to 30 years, the metal underframes of similar cars, after 20 years of service, are in such excellent condition that their total life is estimated at from 50 to 60 years; that the upperframes, when made of iron, being of much smaller sectional areas, will corrode more rapidly and will not last more than 30 years; that the riveting, if of good design and workmanship, will not become loose from shock or vibration, and that serious corrosion in the rivet holes can be prevented by making the rivets completely fill the holes, machine riveting being preferred to hand riveting for this reason; and that the evils of corrosion can be greatly reduced by painting the metal work at least once in three years.

As we have already intimated, the experience of railways in France may not be in all respects directly applicable to conditions in this country, but a number of conclusions valuable for general guidance would appear to be warranted, the first of which is that properly designed steel underframes will last at least twice as long as underframes of wood. Wooden frames in France have apparently a longer life than in this country. Here many place the average life of a freight car at not more than 15 years, but there is good reason to believe that the true figure is nearer 20 years, while French cars of the type investigated last 30 years. As the French underframes of iron have double the life of the wooden ones, and as there do not appear to be any service conditions here particularly prejudicial to metal frames, it is reasonable to expect that the use of steel will double the life of the underframes of American cars. In fact, there is good cause for believing that in this country the life will be more than doubled. In the first place, our cars carry from three to six times as much load as French cars. This means heavier cars with larger steel sections in their frames. These larger sections will suffer from less corrosion, admit of more substantial construction at the riveted joints, and in every way tend to increased life. The only offset to this is the rougher handling of the cars in this country, and even in this respect the difference is more apparent than real, for the heavier and stronger frames required for the heavier loads are better adapted to resist the effects of rough handling. All things considered, therefore, it seems justifiable to conclude that the average life of steel underframes in this country will be at least double that of wood, or, in other words, will exceed 40 years, and that if proper precautions against corrosion are taken this period may be greatly increased.

The second lesson that can be drawn from the condition of the French cars is that, other things being equal, a frame composed of few pieces, and these of relatively large sections, will last longer than a frame having a larger number of smaller parts. The former is also commendable for its simplicity, the reduction of riveted work, and the accessibility of its parts. Such a frame will not only resist the action of the elements better, but it should prove lighter on repairs, less liable to damage in a wreck, and more easily put in shape when damaged.

Another point that should not be lost sight of is the fact that good riveting will not give any trouble in service. It will not loosen from shock or vibration, nor will it corrode if the rivets fill the holes completely. The importance of the rivets filling the holes was brought out by several who took part in the discussion on steel underframes at the M. C. B. convention in June, and need not be enlarged upon here. It is well to point out, however, that the experience of the French does not lead them to consider for a moment the use of bolts instead of rivets.

If we could have given space to all of the engravings which appeared in the original of the article we have translated, the influence of paint as a preservative against rust would be more striking. In the underframes, the corrosion is greatest on such surfaces as are covered by other parts, more particularly those covered by the flooring. Next in order are inner surfaces, not covered, but difficult to reach with a paint brush; and finally there are the exterior surfaces, easily accessible, and almost free from corrosion. It would appear to be a wise precaution to so make steel underframes that when the flooring is being renewed the entire frame could be laid bare, cleaned and painted.

There is not much encouragement for metal upperframes in the article we are discussing. Because of the small sectional area of the various parts, corrosion is an important factor, and they have no longer life than the wooden frames. In this country, the greater size of the cars would permit of heavier sections being employed in the upperframes, from which a greater life might reasonably be expected. But there is little inclination to use metal upperframes in the United States at present, attention being devoted chiefly, and, we think, wisely, to the underframes. As regards the latter, the experience in France, Germany, India or other countries where they are used is unreservedly in their favor,

It is to be noticed that not a word is said regarding the difficulties of conducting repairs in metal instead of wood. And yet French railway officials had to meet the same conditions as our master car builders must face in introducing the steel frames Twenty-five years ago they were using wood exclusively, and now they are using iron almost altogether; they had to accept new conditions and methods for making repairs, and as there is not a word about trouble during the transition, we can only conclude that the difficulties experienced were not as great as some officials in this country expect them to be here.

Another strong testimonial in favor of the steel underframes and the low cost of repairs comes from the few roads in this country that have had any experience with well-designed frames in regular service. The Norfolk & Southern road, for instance, finds that the cost of repairs for the four years it has used steel underframes is practically nothing. It certainly appears that repairs to steel cars will come so slowly and be so small that the problem of making such repairs cheaply can be solved leisurely.

Whether it is better to begin with mixed underframes and afterward take up frames entirely of steel admits of two opinions, but we firmly believe that the better way is to go to all-steel underframes without any intermediate steps. As to the question of special and patented sections versus regular structural shapes, a decision will be reached only after experience with both. Some of the cars constructed from special shapes already brought to the attention of railway officials are admirably designed, but before they will be adopted to any large extent they will undoubtedly be called upon to compete with cars constructed of regular structural shapes. It will then be a survival of the fittest. It would appear that in the designing of steel underframes there is a chance for the mechanical department and the chief or bridge engineer to work together. The latter ought to be able to render valuable assistance.

NOTES.

For five summers the Baltimore & Ohio has been compelled to haul water in tanks from the Ohio River to supply its locomotives in West Virginia, where the mountain streams give out in dry weather. To avoid this a reservoir with a capacity of 3,000,000 gallons is building at Glover's Gap, W. Va. The water will be furnished by artesian wells, several of which have been drilled in the vicinity. On the Pittsburgh Division, near Triadelphia, a similar but smaller reservoir is being built for the same purpose.

The Royal Agricultural Society will hold its 1897 meeting at Manchester, England, when prizes of $500 and $250 are offered for the best self-moving vehicle for light loads, and similar sums for the best heavy self-moving vehicle. Those of the former class are to be designed for loads up to 2 tons, and the latter for loads of 5 tons, the weight of the vehicle itself being excluded. Where petroleum is used, the specific gravity of the oil must not be less than .8, and the flashing point not less than 73 degrees Fahr. The trials will consist of a run of 50 miles and return, and careful measurements of fuel and water consumed will be made. The maximum speed is placed at 10 miles per hour. Entries must be received before April 1 next, and may be sent to Mr. Ernest Clarke, 13 Hanover Square, London, W., from whom further information can be obtained.

The United States Lightship Board recently installed a unique signaling plant on Lightship No. 42, stationed off Cape Cod. The boat's visual signals consist of fixed white lights in gratings at the two mastheads, and its audible signal is an immense whistle operated by compressed air. Power for compressing the air is furnished by two Hornsby-Akroyd oil engines of 25 horse power each. These engines can be started up in from 10 to 15 minutes, and as compressed air is always kept stored in reservoirs of sufficient capacity to run the whistle for 20 minutes, the whistle is ready for service at a moment's notice in case of sudden fog. Theair is compressed to 60 pounds pressure and passes through a reheater and a reducing valve before going to the whistle. The reheating is done on the score of economy and also to prevent the whistle from clogging with the frost and ice that would otherwise be formed by the cooling effect of the expanding air.

The *Monthly Bulletin* of the Bureau of American Republics for June has an article on the railway systems of the Argentine Republic in which the total railway mileage is given at 14,029 kilometers (about 8,760 miles); of this total five lines are the property of the nation with a length amounting to 1,026 klilometers; 10 lines with a total length of 3,834 kilometers are guaranteed by the Government; seven lines of 6,241 kilometers are without national guarantee, and seven lines, comprising 2,928 kilometers are subject to provincial jurisdiction. In 1894 there were in service 1,112 locomotives, of which 868 were of English manufacture, 144 American, 68 French, 12 Belgian, 9 Canadian, 2 German and 4 of home manufacture. There were 1,456 passenger coaches, of which 824 were of English manufacture, 235 American, 184 Argentine, 92 French and 121 the manufacture of which is not given. There were 31,039 freight cars, 17,940 of which were of English make, 6,421 Argentine, 1,496 American, 1,265 French and 3,917 not stated.

The United States navy is not the only one in which there is dissatisfaction because of improper treatment of the engineer officers. In the British navy the same trouble exists and in the hope of educating public opinion to an appreciation of the injustice systematically dealt out to the engineering staff, *The Practical Engineer* began in its issue of May 15 a serial story entitled "The Naval Engineer and the Command of the Seas." In the course of the story war is declared between England and France and the first naval engagement takes place in the Mediterranean, and is described in an interesting manner. The battle might have terminated in favor of the English had not a second French fleet appeared upon the scene, compelling the English to beat a retreat. The importance of the work of the engineering staff is brought out in connection with the maneuvers of the vessels, and the appearance of the second French fleet is attributed to the impossibility of getting engineers and artificers to man a sufficient number of British men-of-war to keep the Frenchmen in port. As a story it is thus far quite interesting, and it is to be hoped it will serve a useful purpose.

One of the new fast passenger engines on the Chicago, Rock Island & Pacific Railway made an excellent run from Chicago to Rock Island on June 3. The run of 181.3 miles was made in 3 hours and 28 minutes, the train making seven stops and seven times slowing down to 25 miles per hour in passing over interlocking plants and bridges. Furthermore, 31 minutes was consumed in going the first 15 miles, because of the difficulty of getting out of the city over the tracks which are being elevated. That leaves only 2 hours and 57 minutes for the remaining 166.3 miles, making the average speed for that part of the run 56.37 miles per hour, including the seven stops and seven slow-downs. The train consisted of five cars, weighing 452,170 pounds, or over 226 tons. The new engines are known as "Class 22 A," and are of the eight-wheeled type. They have cylinders, 19½ by 26 inches; driving-wheels, 78 inches in diameter; radial-stay wagon-top boilers, 61 inches in diameter at the smallest course; total heating surface, 1,988.3 square feet; grate area, 2.45 square feet; boiler pressure, 190 pounds: driving wheel base, 8 feet 6 inches; total wheel base of engine, 23 feet 1½ inches; weight on drivers, 83,000 pounds; weight on truck, 42,000 pounds; total weight of engine in working order, 125,000 pounds. The engiues have large bearings and wearing surfaces. The boiler is of carbon steel, the driving-wheels of cast steel, the axles of Cambria steel, treated by Coffin process, Krupp steel tires, Nathan sight feed lubricators, Ashton safety values and mufflers, Jerome metallic packing. French springs, Star steam gages, American driver brakes, Sargent driver brake shoes, Monitor injectors, Barabor bell-ringers, Mason reducing valves, Marden brakebeams and Westinghouse brakes on tenders.

Personals.

Mr. L. A. Riley has been elected President of the Lehigh & Lackawanna Railroad.

Mr. Leon Hart has resigned as Receiver of the Texas, Sabine Valley & Northwestern.

Mr. K. H. Bates has been elected President of the Kansas City, Oklahoma & Southwestern.

Mr. J. T. Atwood has been appointed Chief Engineer of the Pittsburgh & Lake Erie Railroad.

Mr. Hugh J. Fitch has been appointed Receiver of the St. Louis Avoyelles & Southwestern Railway.

C. C. Crooke, President of the Altamont & Manchester Railroad, died at Stanford, Ky., on July 9.

Mr. S. T. Prince, of Mobile, has been appointed Receiver for the Seaboard Railway Company of Alabama.

Mr. Sidney Emerson has been appointed Chief Engineer of the Wabash, with headquarters at St. Louis, Mo.

Mr. T. H. Perry has been made Purchasing Agent of the Cleveland, Akron & Columbus, with office at Indianapolis.

Mr. B. E. Taylor is appointed Purchasing Agent of the Louisville, New Albany & Chicago, vice J. H. Craig, resigned.

Mr. William J. Dale, Jr., has been reappointed a State Railroad Commissioner of Massachusetts for three years from July 1.

Mr. Chas. H. Grundy has been appointed General Manager of the Marshfield & Southeastern, with office at Marshfield, Wis.

Mr. W. H. Smith is appointed Purchasing Agent for the Atlantic & Pacific Railroad, with headquarters at Albuquerque, N. Mex.

Mr. George W. Kenny is appointed Superintendent of Motive Power of the Rutland Railroad, with headquarters at Rutland, Vt.

Mr. A. McLean has been appointed Superintendent of Motive Power and Equipment of the Georgia Northern, with headquarters at Pidcock, Ga.

Mr. Joel H. De Victor has been chosen Vice-President of the Eagles Mere Railroad, with headquarters at Philadelphia, Pa., vice Mr. John R. T. Ryan.

Mr. Joseph McWilliams has resigned as General Superintendent of the Texas Central to accept the position of General Manager of the Marietta & North Georgia.

Mr. William Youngquist, for more than 25 years Foreman of the Chicago, Burlington & Quincy Car Department, died at Creston, Ia., on June 22, aged 54 years.

Mr. W. J. Lewis has been appointed Purchasing Agent of the Peoria, Decatur & Evansville Railway, with headquarters at Evansville, vice H. W. Matters, resigned.

Mr. S. B. Fisher, formerly Assistant Chief Engineer, has been promoted to the position of Chief Engineer of the Missouri, Kansas & Texas, with office at St. Louis, Mo.

Mr. John H. Winder, President of the Seaboard Air Line Belt Railroad at Atlanta, Ga., has resigned, and Mr. R. C. Hoffman, of Baltimore, has been chosen to succeed him.

Receiver and General Manager C. W. Smith, of the Atlantic & Pacific, has removed his headquarters from Albuquerque, N. Mex., to the Great Northern building, Chicago.

General Manager J. H. Macleary, of the Suffolk and Carolina Railway, has resigned and General Superintendent Geo. L. Barton will for the present perform the duties of the office.

Mr. W. F. R. Mills has been appointed General Superintendent and Purchasing Agent of the Denver, Lakewood & Golden, vice J. B. McCormic, previously General Superintendent.

Mr. O. O. Winter, Superintendent of the Willmar Division of the Great Northern, has resigned to become General Manager of the Brainerd & Northern road, a lumber line in Minnesota.

Superintendent Conklin, of the Buffalo, Attica & Arcade, has resigned. Samuel T. Dyke is acting as Master Mechanic, and has entire charge of the roadbed, construction and rolling stock.

Mr. Sanford Keeler, recently General Manager of the Saginaw, Tuscola & Huron road, in Michigan, has been appointed General Manager of the Interurban Electric Railroad, at Saginaw, Mich.

On July 1 Mr. J. Gibbons retired as Chief Engineer of the Vandalia, and his duties devolved upon Mr. F. T. Hatch, in connection with his duties as Superintendent of the Michigan Division.

Mr. Henry G. Morse has accepted the presidency of the Harlan & Hollingsworth Company, ship and car builders, succeeding Mr. W. Taylor Gause, resigned. Mr. Morse was fornerly President of the Edge Moor Bridge Works.

Mr. Joseph H. Green, Master Mechanic of the Southern Railway of Columbia, S. C., has resigned to accept the position of Superintendent of Motive Power and machinery of the South Carolina & Georgia Railroad, with headquarters at Charleston, S. C.

Mr. William Berdan, Secretary and Treasurer of the Cooke Locomotive and Machine Company, of Paterson, N. J., has resigned to become Secretary of the National Association of Locomotive Builders, with offices at 26 Cortlandt street, New York City.

Mr. Horace G. Burt, General Manager of the Fremont, Elkhorn & Missouri Valley, will succeed Mr. E. W. Winter as General Manager of the Chicago, St. Paul, Minneapolis & Omaha. Mr. Burt was formerly Chief Engineer of the Chicago & Northwestern Railway.

Mr. George F. Bidwell, Superintendent of the Ashland Division of the Chicago & Northwestern, has been made General Manager of the Fremont, Elkhorn & Missouri Valley lines, to succeed Mr. Horace G. Burt, who becomes General Manager of the Chicago, St. Paul, Minneapolis & Omaha line.

Mr. John C. Sanborn, Superintendent of the Plymouth Division of the Old Colony road, has been elected General Manager of the Boston Terminal Company, which is to build the new Southern Union Station in Boston. He will make a trip abroad to inspect European railroad passenger stations.

Mr. A. G. Wright has been appointed Division Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, with headquarters at Altoona, Wis. He succeeds Mr. W. E. Amann, who resigned to accept the position of mechanical expert for the Galena Oil Company, on the Southern Pacific system.

Mr. B. F. Yoakum, Third Vice-President and General Manager Gulf Colorado & Santa Fe, has been appointed Vice-President and General Manager of the reorganized St. Louis & San Francisco Railroad. Mr. Yoakum has been with the former road for three years, and was previously for several years General Manager and for some time Receiver of the San Antonio & Aransas Pass Railway.

Mr. Nicholas Monsarrat has resigned as President and General Manager of the Columbus, Sandusky & Hocking. He was appointed Receiver of the road in July, 1895, and when the company was reorganized last November he was chosen President and General Manager. He was formerly President and General Manager of the Cleveland, Akron & Columbus.

Mr. A. L. Studer is appointed Master Mechanic of the Southwest Division of the Chicago, Rock Island & Pacific, in charge of the locomotive and car department, with headquarters at Trenton, Mo., vice Mr. Wm. Gessler, resigned. Mr. J. B. Kilpatrick is appointed Master Mechanic of the West Iowa Division in addition to his other duties as Master Mechanic of the K. & D. M. and D. M. & Ft. D. Division, with headquarters at Valley Junction, Ia.

Mr. H. L. Morrill, who retires from the positions of Vice-President and General Manager of the St. Louis & San Francisco road, was Manager of Construction in the building of the Nickel Plate line, and was also at one time General Manager of the Hoosac Tunnel road. He entered the service of the St. Louis & San Francisco Company June 1, 1886, as General Manager, and in 1887 was also made Vice-President, and has been with the company ever since.

Equipment Notes.

The Baltimore & Ohio will soon order a number of combination cars.

The Delaware, Lackawanna & Western is in the market for 1,200 cars.

The Bangor & Aroostook Railroad is in the market for between 600 and 1,000 freight cars.

The Carlisle Manufacturing Company has secured an order for 250 cars for the Pennsylvania.

The Boston & Albany is reported as being in the market for quite a number of passenger cars.

The Chicago Great Western has ordered a new Pullman dining-car for use on its Chicago division.

The Pennsylvania will build eight engines at its own shops for the Western Pennsylvania Division.

The Philadelphia & Reading road has let a contract for 500 freight cars to the Depew Car Works.

The Southern Car Line, with headquarters at Atlanta, Ga., will shortly build about 2,200 freight cars.

The Cincinnati, Jackson & Mackinaw received last month five new day coaches and three baggage cars.

Specifications are out and bids are asked for by the Swift Com-Company for 100 or more refrigerator cars.

Orders for the construction of five "Class R" locomotives have been received in the Erie shops at Susquehanna, Pa.

The Shippers' Refrigerator Car Company, 105 Royal Insurance Building, Chicago, are asking bids upon 10 refrigerator cars.

The Indiana Tank and Refining Company, Rookery, Chicago, has recently organized to transport oil, is in the market for 50 tank cars.

The Erie order for 20 engines was divided equally between the Cooke Locomotive & Machine Company and the Rogers Locomotive Works.

The rumor that the Grand Trunk was in the market for about 4,000 cars is denied, but later reports are to the effect that cars will be ordered in the fall.

The Georgia & Alabama has contracted with the Richmond Locomotive Works for six new locomotives, four for freight and two for passenger service.

It is reported that Nelson Morris & Company will soon increase the number of refrigerator cars ordered from the United States Car Company. The present order is for 55 cars.

The Alabama Great Southern Railroad has placed an order for four locomotives with the Richmond Locomotive Works, three being 10-wheel passenger engines and one for switching service.

The Rome, Watertown & Ogdensburg has placed in service a number of new day coaches, each seating 64 passengers. They have Hale & Kilburn seats, and are mounted on Krupp steel wheels.

The St. Charles Car Works have completed three 60-foot postal cars for the St. Louis & Iron Mountain, embodying several improvements suggested by E. J. Peck, General Superintendent of that road.

The Michigan Central Railroad Company is said to have set aside $200,000, which will be expended in new equipment this fall. This road expects to order 12 or more locomotives and about 900 freight cars.

The Butler & Pittsburgh Railroad will soon, according to a Pittsburgh daily, be in the market for a large number of ore cars and locomotives, the intention being, it is said, to spend about $4,000,000 on equipment.

The Illinois Central has 800 cars under contract for delivery in July and August. These orders include 300 refrigerators and 500 coal cars. The road is reported to be in the market for 1,800 cars, but the officers have denied the truth of the report.

New Publications.

THE OFFICIAL RAILWAY LIST, 1896. FIFTEENTH ANNUAL EDITION. *A Complete Directory of Railway Officers etc., and Handbook of Useful Information for Railway Men.* Published by the Railway List Company, Chicago. 403 pages. 4½ by 8¼ inches.

This yearly visitor comes to us with its usual smiling exterior and roseate with red edges. It is filled from title page to "finis" with names of railroads, people, addresses and—advertisements. It is not easy to test the accuracy of the information which it publishes. One of our contemporaries has pointed out some errors which it contains, which leads to the observation that an annual list of this kind of necessity cannot be as accurate and as fully up-to-date as one which is published monthly, like that given in each number of the AMERICAN ENGINEER, CAR BUILDER AND RAILWAY JOURNAL, and which can be corrected 12 times in a year instead of only once. The official list is of a convenient size and form, and is fat with advertising, which denotes prosperity and peace of mind to its properietors, and the esteem in which the publication is held by its patrons.

THE RAILWAY AGE AND NORTHWESTERN RAILROADER, Chicago.

With its issue of July 3d this well-known journal, following the example set by the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, reduced the size of its pages to 9 inches by 12 inches, and, as a result, it now comes before its readers in an exceedingly neat dress. Its management is to be congratulated for its enterprise in adopting the new form, and the readers of the paper will undoubtedly appreciate the change.

THE ENGINEERING INDEX, VOL. II., 1892-1895 Edited by J. B. Johnson, C. E. Published by the *Engineering Magazine*, New York. 474 pages. 6½ by 9½ inches. Price $4.

The material composing this volume has appeared in the monthly numbers of the *Journal of the Association of Engineering Soc eties* during the past four years. The first volume was published by the managers of the *Journal* and covered seven years immediately preceding 1892. The present volume is published by and at the expense of the *Engineering Magazine.* This enterprising publication has for some time past been conducting an excellent index to engineering literature and it so completely covered the field that the management of the *Journal* has discontinued its index. To those of our readers who are familiar with the index as it has appeared in our contemporary from month to month, no words of commendation are necessary. To others we would say that we believe it is compiled on the only satisfactory basis for such a work, in that it indexes only such articles as appear to have a permanent value and in a few words outlines the contents of each, so that the reader can judge for himself whether an article is of the character he is seeking. An index which omits to give any indication of the scope or value of its articles falls short of what is required, and one in which nearly everything is indexed becomes too voluminous. But when a selection is made from the great mass of current literature it must be done wisely, and the fact that in this case the selection has been performed by technical experts is a guarantee that is well done. Hereafter, the volumes of the Engineering Index will appear annually, and we are sure they will be welcomed by all who realize that between the covers of these books, if anywhere, there is to be found a complete index of all important articles on any engineering subject they may desire to investigate. We may, each for himself, save clippings or index articles bearing on our own special lines of work, but we don't cover the whole field, and when one seeks information outside of his specialties, he is very much at sea without such an index.

"New York as a Summer Resort;" No. 19 of the "Four Track Series."

This is the title of a neat and attractive little book just issued by the Passenger Department of the New York Central road. It has nearly 100 pages, and is 4 inches by 8 inches in size. It contains much valuable information about the city's hotels, restaurants, theaters, museums, parks, excursion resorts, roof gardens, bathing beaches, fishing grounds, bicycle roads, etc. Its pages are illustrated with many fine engravings, and nothing of interest about the city has been omitted. A brief study of the book is sufficient to convince one that there is much in New York to entertain and interest the summer visitor. A copy of "New York as a Summer Resort" will be sent free, postpaid, to any address on receipt of two 2-cent stamps by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

Books Received.

Ninth Annual Report of the Interstate Commerce Commission, 1895. The Government Printing Office, Washington, D. C. 301 pages, 6 inches by 9 inches.

Annual Report of the Massachusetts State Board of Arbitration and Conciliation for 1895. 187 pages, 6 inches by 9 inches.

Twenty-Seventh Annual Report of the Board of Railroad Commissioners of Massachusetts, including railroad returns for the year 1895. 1082 pages, 6 inches by 9 inches.

Annual Report of the Chief of Engineers, United States Army, 1895. Government Printing Office, Washington. Seven volumes.

Speed Control of Modern Steamers.

Under the above title Lieut. M. L. Wood, U. S. N., has presented to the United States Naval Institute an interesting paper, suggesting a practical method of directly controlling the engines of steamers from the bridge. After reviewing the practice and improvements in engine-room signals, he proceeds to describe the proposed methods, from which we take the following:

The question naturally comes up, Why is it not practicable to connect the engine telegraph, or a modified form of it, suitable to the new conditions, directly to the mechanism controlling the direction of motion with the speed of the engine, so as to work the engines directly from the pilot-house instead of from the engine-room platform?

It is the object of this paper to show that such a connection is practicable, that it can be made reliable and that it is advisable, on the score of efficiency, by eliminating chances of error in transmitted signals, with increased rapidity in working engines, while preventing damage to engines and lessening the chance of accidents, by allowing constant general inspection while under way by those now stationed to work engines by hand in obedience to signals.

The following is the plan proposed for adoption without interfering with working the engines exactly as at present, when so desired. When the principle is once adopted simplifications can easily be arranged, lessening the number of parts to suit the size of vessel and the different types of engines.

1st. Connect the engine-room telegraph, modified to suit the work, or a special connection designed for the purpose, to a small pinion or suitable gearing, which will move the valve of a small commercial steam steering engine the full extent of its throw, by the movement of the lever in the pilot-house, the motion being so adjusted that the "stop" position of the lever agrees with the position of the valve for "helm amidships." For convenience, call this small steam steering engine the "regulator engine." The pattern is immaterial, only the valve must be specially designed to move with as slight friction as possible, owing to the small travel of the lever.

2d. In place of the drum on the regular engine, fit a shaft, which, by worm and gear or rack and pinion movement, will move a frame sliding in horizontal guides, exactly as the tiller end is moved by a steam steering engine—the middle part of the travel of the frame corresponding with the "stop" position of the lever in the pilot-house and with the "amidships" position of the valve of the steam steering engine used for the regulator engine.

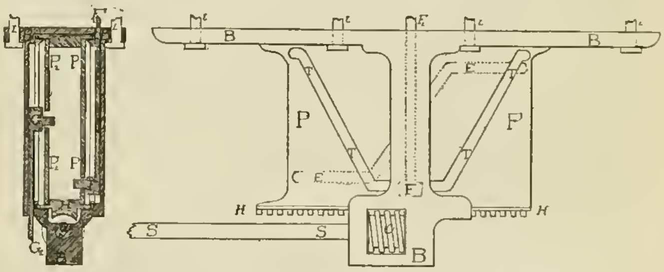
3d. To the frame, called for convenience the "regulator," attach two vertical stiff plates. One of these plates has guide pieces riveted on, or a slot cut, in which a cam, moving in vertical guides, slides. This cam is connected with the valve of the ordinary reversing engine governing its motion. The other plate is connected in precisely the same manner with the main throttle valve. The motion of both cams is controlled by the shape of the slots in which they work, thus regulating the position of the valve of the reversing engine and also the position of the throttle. For every position of the "regulator" there is but one position of the throttle valve and one position of the reversing engine; also these positions will be exactly those required for the most efficient working of the particular engine.

During the middle third of the travel of the "regulator," the direction of motion of the engine is controlled; the outer parts of the travel regulate the speed from "slow" to "full speed" with any degree of nicety required.

4th. Arrange simple accessible means for throwing the automatic engine control apparatus out of action on the shortest notice, allowing the engine to be worked by hand as at present.

There is one mechanical difficulty that interferes with this plan at present. The plan proposed for using these engines as regulator engines will require an easier movement of the valve than is usual with commercial steam steering engine valves. Manufacturers will be able to produce easy moving valves when once in demand; the more readily that as the regulator engine in this plan has to move only two light valves instead of a heavy rudder, subjected to violent jerks, a very small, lightly made steam steering engine will handle the engines of the largest battleship.

Let it be assumed that the motion of the pilot-house lever of the ordinary form of engine telegraph through an arc of 90 degress will give a motion of six inches, the whole travel, to the valve of a small "regulator" engine in the engine-room. Then it necessarily follows that the sliding frame or regulator can be made to follow the mo-



Regulator for Controlling Engines from Bridge.

tions of this valve exactly, by means that are thoroughly tested and reliable. Suppose the drum of the steam steering engine be attached to the shaft shown in *S S*, Fig. 1, which, by means of the worm wheel, *O*, and the cogs, *H H*, gives a rectilinear motion of say 3 feet to the plates, *P P* and P_2 P_2, sliding in bracket, *B B*, Figs. 1 and 2. The movements of the rod, F_2, connecting with the throttle, are governed by the guiding slot, *T T*, and cam, *F*, Figs. 1 and 2. The movements of the rod, G_2, connecting with the valve of the reversing engine, or, preferably, directly to the links of the main engine, are governed by the guiding slot, *E E*, and the cam, *G*, Figs. 1 and 2, in the plate P_2 P_2, Fig. 2.

(Two separate guide slot plates are shown to bring out principle.)

The figures show the regulator in mid-position with the steam shut off and the links half up. The shape of the slots and their relation to each other would be determined by the particular type of engine, but would be designed for the most efficient and safest handling. The location of the regulator engine would be such as to allow the shortest and simplest connections with the engine-room telegraph. It could be under the engine-room floor or where least in the way. The location of the sliding frame would be close to the engines, where least in the way, against a bracket shelf on a bulkhead, under the engine-room floor, or overhead—the location, except for convenience, being immaterial. The motions from the cams to the reversing engine and the throttle are communicated by bell-cranks or other suitable connections.

The auxiliary machinery, such as circulating and air pumps, can be controlled with but little trouble by additional slots and cams. In fact, all routine movements now performed by hand successfully can be arranged to take place at the exact time required for efficient working without the possibility of mistakes.

No provision is made for the sending of any return signal to the bridge while working automatically, as the motion of the engine will show on the "engine indicators" in the pilot-house, and will be the best and surest indication that can be devised.

In case it be assumed that the engine telegraph cannot be made strong enough, or the friction of the valve with its resistance reduced sufficiently, the valve on the regulator engine can be made to move by a lever of sufficient power, connected with the valve by means similar to, but lighter and simpler than, the connections to the steering engine in the steering-engine compartment.

The primary object of the automatic working of the main engines directly from the dock is increased efficiency. Time will be saved by its use, as well as the elimination of the chance of accident from misunderstanding or faulty execution of signals. Such mistakes have happened with the best men at the throttle, and may happen again. The power of working the engines at all times may be of vital importance. A small piece of a projectile during battle might cut even a small auxiliary pipe filled with live steam, which might make an engine-room uninhabitable before steam could be shut off. The destruction of the draught might fill the compartment with poisonous gases. During the time the engine-room was thus cleared of living beings, might occur a critical moment when the safety or destruction of the vessel would depend on the handling of the engines promptly. The plan proposed would allow the engines to be controlled the same under such conditions as at any other time.

In a vessel dependent on the motion of the engines for propulsion, the importance of the proper working of the machinery at all times, but especially in action or in times of danger, cannot be overestimated. A collision or a torpedo explosion might result in such danger to those below decks that the engine-room would be cleared on account of the possibility of going down with the ship. Control of the engines from the deck would prevent the loss of life due to the vessel sinking while going through the water, or carrying down those remaining at the post of duty in the engine-room.

Various changes will suggest themselves to experts looking over the details of the plan here proposed for speed control. The details as given may appear cumbrous, as the one idea has been to make the principles clear, and this could be done only by sacrificing small details to bring out the general effect. Keeping the reversing engine available for use when desired has also added unnecessary parts. When once the principle is adopted there will be time and opportunity for introducing improvements in many directions to save room and get rid of useless parts.

The following are some of the advantages which would attend the adoption of automatic control of engines :

1st. Avoidance of errorr and accidents due to misunderstanding or poor execution of signals from deck.

2d. Quicker working of the main engines, since the motion of one lever on the bridge acts directly on both the reversing engine and the throttle. The engine will be worked in the same time it now takes to make the signal.

3d. Complete control of the engines while steam is in the boilers, in case an accident to a steam-pipe or the draught makes the engine-room untenable, or a serious incident, such as being rammed or torpedoed, forces those in the engine-room to leave their post.

4th. Greater efficiency in handling the engine with increased security from accidents due to imperfections in the machinery or its working, by allowing those now stationed strictly on the engine platform when under way to move freely about the engine-room, inspecting all parts more frequently.

5th. Relief from constant strain of those now stationed to watch engine-room telegraph when under way.

6th. Adaptability to any form of engine without lessening usefulness of present system of reversing engines by hand.

7th. Ready return to existing style of working engine when so desired.

8th. Adaptability of present connections of engine telegraph to new system of working engines without any increase in number of parts or the use of untried systems of connection.

9th. Exact and delicate adjustments of speed to suit the exigencies of squadron evolutions in close order.

A Water Power and Compressed Air Transmission Plant for the North Star Mining Company, Grass Valley, Cal.*

BY ARTHUR DE WINT FOOTE, M. AM. SOC. C. E.

Upon the prohibition of placer mining by the State of California, the immense canal systems extending over the western slopes of the Sierra Nevadas were left without a purpose, and their future existence depended upon a new use for water. Out of this necessity has grown a business of selling water for power and irrigation, retaining the original methods of delivery at the bank of the canal and miner's inch measurement. The price of water is approximately 1 cent per 1,000 gallons, delivered at the canal : its cost for power depends upon the pressure that can be obtained from it. In the case of the North Star plant, it could have been conveyed directly to the mines and have done its work there on different wheels more or less adapted to the varying conditions; but there is a certain inconvenience and danger in using water in this manner under a high pressure, and, moreover, the mines are on a hill. So it therefore seemed advisable to convey the water directly to the lowest convenient point, obtain the power there, and transmit this power to the places where it was needed.

This brought forward the subject of transmission of power, and electricity was naturally suggested first. Visits to mines in operation and careful study and investigation of electrical appliances for underground work, especially pumping, finally decided the author in favor of compressed air. The latter method, under the conditions, was believed to be most economical of power, least liable to accident and cheapest in first cost. Moreover, almost absolute security against stoppage could be obtained by having a set of boilers on hand ready for firing up in case the water power or air plant gave out, for, by the use of these boilers and opening and shutting a few valves, all the air motors become equally good steam motors; whereas, with electrical transmission an entire set of steam motors would have to be provided to give equal security; or as the air and steam motors are the same, the electrical motors would require just so much extra expense in cost of plant of equal security against stoppage.

The water supply is obtained from the South Yuba Water Company, at a point on their canal about four miles from Grass Valley, Nevada County, Cal. Thence it is conveyed about 2½ miles to the Empire Mining Company's works in a 22-inch riveted iron pipe, built more than 10 years ago. The new conduit is a riveted steel pipe, 20 inches in diameter, joined to the lower end of this old one under a head of 420 feet, and continues 7,070 feet to the power-house, situated at the lowest convenient point on Wolf Creek, just below the town of Grass Valley, where a head of 775 feet, or a static pressure of 335 lbs. per square inch, is obtained. The capacity of this pipe is sufficient to develop 800 to 1,000 horse power.

At the power-house there is a Pelton water wheel, 18 feet 6 inches diameter, running on a 10-inch shaft, to which a duplex compound air compressor is connected directly. The inital cylinders are 18 inches, and the second cylinders are 10 inches in diameter, with a 24-inch stroke. They were designed to run at 110 revolutions per minute, and require 283 horse power from the water wheel.

A six-inch lap-welded pipe conveys the air at 90 pounds pressure from the power-house to the company's Stockbridge shaft on Massachusetts Hill, 800 feet distant and 125 feet higher. Here it is now being used in a 100 horse-power cross-compound Corliss pneumatic hoisting engine, and a 75 horse-power compound pump, beside other pumps, blacksmith forge, drills, etc.

The Pipe Line.—The line of the pipe is quite crooked, both horizontally and vertically. It is laid in a trench four feet deep, dug with plows and scrapers, except where too stony, and the joint holes were dug by hand. The total cost of all the work of burying the pipe, including covering a large portion of it with stone from the mine dumps, and cement masonry wells for the valves and for sustaining the pipes around bends, amounted to approximately $6,756.27. This was done on company account, after refusing bids, the lowest of which would have amounted to about $8,500. An aqueduct of cement masonry across Wolf Creek at the power-house is not included in this estimate, but was built on company account, and cost $1,435.

The Risdon Iron and Locomotive Works of San Francisco manufactured the pipe from the 48 by 66 inch sheets (rolled by the Central Mills of Harrisburg from slabs furnished by the Pennsylvania Steel Company) and laid it complete in lengths of about 28 feet in the

* Abstract of a paper read before the American Society of Civil Engineers, June 28, 1896.

trench under the following schedule, the longitudinal seams being double riveted by hydraulic riveters:

Head in feet.	Length.	No. B. W. G.	Thickness.	Rivets.	Remarks.
420 to 500	2,320 ft.	9	0.148 in	3/8 in.	Cold riveted
500 to 600	2,110 ft. 6 in.	8	0.165 in.	3/8 in.	"
600 to 700	1,158 ft.	7	0.180 in.	7/16 in.	"
700 to 750	1,204 ft.	6	0.203 in.	1/2 in.	Hot riveted
750 to 775	285 ft.	5	0.220 in.	1/2 in.	"
Receiver	40 ft.	... .	0.375 in.	9/16 in.	"

The pipe was dipped, after being made into lengths, into the usual hot asphaltum mixture and P. & B. paint was used to cover all surfaces not protected by the asphaltum when the pipe was in place.

About 1,000 feet from the lower end a 12-inch branch with a gate is put in for possible future use, and near it is a 20-inch gate. At the lower end of the pipe in the power-house there is another 20-inch gate, below which is a 12-inch branch leading to the Pelton wheel, and and adjoining this is the receiver, 2 feet in diameter, on which are the air chambers, charging tube and relief valve. The air chamber is a 10-inch lap-welded tube 18 feet long standing on the receiver, with an 8-inch gate between. The charging tube is similar, but 8 inches in diameter. Both have 2-inch water discharge pipes and gates, and by proper manipulation of the gates and the operation of inlet check valves on top of the tubes, the air chamber may be filled. Ordinarily the charging-tube is filled up to 90 pounds pressure from the air compressor delivery pipe, and then raised by the water pressure. It is found necessary to put in about one-tenth of the volume of the air-chamber every day. Where the air goes is, thus far, a mystery, as no leak has been discovered.

Water Wheel.—The demand for direct action under a head of 775 feet made a large wheel necessary in order to obtain the proper peripheral speed of half the spouting velocity. The manufacturers objected seriously to undertaking anything over 15 feet in diameter; whereas the proper speed of 60 to 70 revolutions for the compressors required a wheel of nearly 30 feet diameter. A compromise was finally made with a wheel of 18 feet 6 inches diameter, and a compressor revolution of 110 per minute, and the Pelton Water-Wheel Company, of San Francisco, built the wheel from a design by Mr. E. S. Cobb. Had the design been prepared sooner, the wheel could have been made 30 feet in diameter equally well. The Pelton Company guaranteed an efficiency of 85 per cent. at full load, and an average of 75 per cent. from half to full load of the theoretical power of the water, and, at the same time, to so govern the wheel that it should not exceed 120 revolutions nor raise the air pressure above 105 pounds per square inch in case of accident to machinery or sudden shutting off of air. The rim is built up of angles and plates riveted together to break joints. It weighs about 6,800 pounds, and is held concentric with the shaft by 12 pairs of radial spokes of 1¼-inch rod iron held by nuts to the cast-iron hub. The driving force, being applied to the rim, is transferred to the hub by four pairs of 2-inch iron rods, so arranged as to form a truss. The wheel is set on a 10-inch shaft, having a disk crank on either end and connected directly to the compressors. The regulator is a floating valve actuated against excessive velocity by the ordinary ball governor and against excessive air pressure by a spring set to move when the air pressure in the delivery pipe exceeds 90 pounds.

Repeated tests which checked very closely give the wheel an efficiency of a trifle over 90 per cent. for one-quarter, one-half, three-quarters and full loads. Between these points it is somewhat less, as the hood coming down over the nozzle tends to deflect the water as well as hold it back, and decreases the efficiency. It seems probable that the long radius of the wheel accounts for the high efficiency.

Compressors.—Mr. E. A. Rix, of San Francisco, who has made a careful study of air compression, designed the compressors, and they were built by the Fulton Engineering and Ship-Building Company of San Francisco. They are made very heavy, to stand the high piston speed required by the conditions of the water power. Had it been known at the time of designing this plant that a wheel could have been made like the one described, a diameter of 30 feet instead of 18 ft. would have been chosen and the piston speed of the compressors reduced accordingly. The compressor cylinders are 18 and 10 inches in diameter and 24 inches stroke.

The most novel feature of these machines is the intercooler. This is made up of 49 soft copper pipes, 1 inch in diameter, 18 feet long, each with a stuffing box at each end connected with manifold castings. The air delivered from the first cylinder into one manifold passes through these pipes to the other manifold, from which it is taken to the second cylinder. The whole is placed in the wheel pit directly under and in front of the wheel, so that the water dashes all over and through it. The air, leaving the first cylinder at a temperature of 200 degrees Fahr., passes through the intercooler and enters the second cylinder at 60 degrees, slightly cooler than when entering the first cylinder. The temperature is again raised to 204 degrees on leaving the second cylinder and passing into the transmission pipe, showing a total rise in temperature of 282 degrees Fahr.

The transmission pipe, conducting the air at 90 to 100 pounds pressure about 800 feet from the compressors to works at the mine, is ordinarily well tubing 5¾ inches in diameter inside. At the mine there is the ordinary air receiver and also three 50-horse power boilers set ready for steam, which are used for receivers.

The air is taken from these into the reheaters designed by Mr. Rix and built by the Fulton Company. It requires a little over half a cord of good pine wood each 24 hours to heat about 700 cubic feet of free air per minute to a temperature 350 to 400 degrees Fahr. The heated air passes through pipes covered with magnesia and hair felt to the first cylinder of the hoisting engine, from which it is exhausted back into the upper heater, where its temperature is again brought to 350 degrees, whence it passes to the second cylinder at 30 pounds pressure. From this it is exhausted through a flue to the change house, where it is used for heating and drying clothes. From the first heater also the air for the pump is conveyed some 300 feet down the shaft in a similarly covered pipe. It receives the air at about 275 degrees and exhausts it into the shaft at about 60 degrees, thus giving plenty of pure cool air to the men, without the usual fans or ventilators.

There is a direct-acting donkey pump situated in another shaft 750 feet distant, to which air is carried cold in a 2-inch pipe over the surface. An old hot water heater is used as a reheater for the air, and consumes 12 sticks of pine cord wood per 24 hours.

The hoisting engine is a compound direct-acting Corliss of 100 horse power with cylinders jacketed for hot air, and is calculated to work 3,000 feet down an incline of about 35 degrees.

Efficiencies.—The plain tale is this. There is 304 theoretical horse power in the water used at the power house, the work actually accomplished at the mine amounts to 203 horse power, and the cost of reheating is $3 per day.

Efficiency of compression and transmission from water wheel to motors, and not including cost of reheating.................. $\frac{225.32}{283}$ = 79.5 per cent.

Efficiency of compression and transmission from theoretical power of the water to the motors, and not including cost of reheating.................. $\frac{225.32}{304}$ = 74 per cent.

Efficiency from the water wheel to and through the motors, not including reheating.................. $\frac{202.7}{283}$ = 71.6 per cent.

Efficiency from the theoretical power of the water, to and through the motors, and not including the cost of reheating.................. $\frac{202.7}{304}$ = 66 per cent.

Efficiency of compression and transmission from water wheel to motors, including the cost of reheating expressed in water power.................. $\frac{225.32}{307.66}$ = 73 per cent.

Efficiency of compression and transmission from the theoretical power of the water to the motors, including the cost of reheating expressed in water power.................. $\frac{225.32}{329}$ = 68.4 per cent.

Efficiency of compression and transmission from the water wheel to and through motors, including cost of reheating expressed in water power.................. $\frac{202.7}{307.66}$ = 65.5 per cent.

Efficiency of compression and transmission from the theoretical power of water to and through the motors, including cost of reheating expressed in water power.................. $\frac{202.7}{329}$ = 61.6 per cent.

Horse power of air at works after reheating.................. 225.32
Horse power delivered to compressors by water wheel.................. 283
Theoretical horse power of water used on the wheel.................. 304
Horse power of work actually done by the motors.................. 202.7

The horse power delivered by the water wheel to the compressor, to which is added the horse power (24.66) which the cost of the wood used in reheating would buy in water.................. 307.66 = 283 + 24.66

The theoretical horse power of the water used on wheel added to the horse power (24.66) which the cost of the wood used in reheating would buy in water.................. 329 = 304 + 24.66

It may be urged that the conditions are particularly favorable to compressed air, as the transmission is short and the power is not needed for tramways or lighting. But were it 20 miles instead of 1,000 feet, it is thought by the author that, taking the whole plant, compressor, transmission pipe and motor, as against generator, transmission wires, transformers and electric motors, the air will prove cheaper in first cost, higher in efficiency, less liable to accident, and less expensive to operate and maintain.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued from Page* 137.)

We will now compare the full-length waist-shaped stacks with those that have been shortened, so that we will obtain values similar to those brought together above. As an example of the full-length stack, we take one with a diameter of 14.76 inches, an inclination of $\frac{1}{12}$, a nozzle distance of 18.9 inches and one 15.75 inches in diameter, an inclination of $\frac{1}{12}$, nozzle distance 30.71 inches, and shortened 11.81 inches; also one shortened like the above 11.81 inches, but having a diameter of 14.76 inches, an inclination of $\frac{1}{6}$, a nozzle distance of 18.9 inches, and one 15.75 inches in diameter, shortened 17.8 inches, the inclination being $\frac{1}{6}$ and the nozzle distance 24.88 inches. These are grouped in Table XX.

TABLE XX.

			Full length. Waist diameter = 14.76 inches.	Shortened 11.42 inches. Waist diameter = 15.75 inches.
	Inches.	Inches.	Inches.	Inches.
Inclination $\frac{1}{12}$	D = 18.11			
	d = 14.76	Nozzle diameters 3.94	3.25	3.15
	d_1 = 15.75	4.74	4.06	3.94
			Shortened 11.81 inches.	Shortened 17.80 inches.
	Inches.	Inches.	Inches.	Inches.
Inclination $\frac{1}{6}$	D = 19.49			
	d = 14.76	Nozzle diameters 3.94	2.13	2.11
	d_1 = 15.75	4.74	2.83	2.76

Further examples are also given by the diagrams of Plates III. and IV. as well as by the group of stacks given in Fig. 41.

The preceeding values for the vacuums were obtained entirely independently of each other, on the experimental apparatus, and in each group of stacks comparisons are made with equal nozzle diameters. The difference of a few hundredths of an inch can make no real difference in practice. Hence we may draw the following conclusion:

The shape of the foot of the stack is, for about the lower third of the total height of the stack, without any noteworthy influence upon the action of the air, provided that the current of steam with its surrounding mantle of air finds a free entrance into the stack.

It is, therefore, practically speaking, a matter of no importance whether the base of the stack is cylindrical or conical in form, provided only that it is large enough. In this connection, it may be said that in locomotive practice we frequently find a conical stack setting upon a cylindrical base. It is always well, however, to use a slightly wider foot under a conical stack, since, when steam is being raised as well as when the locomotive is running without steam, it creates a slight draught of the products of combustion.

(*c.*) *Condensations Emitted from the Experimental Stacks.*

A peculiar phenomenon connected with these experiments with the apparatus was the shower of condensed water blown from the stack and which has already been mentioned in Section II. It started from a certain position of the nozzle. Lower temperature affected the shower somewhat, but in the hottest months of the summer there was but comparatively little difference. The larger the nozzle opening the earlier the phenomenon appeared, that is to say, the shorter the nozzle distance up to the smallest section.

The shower usually began feebly, increased with the decreasing distance of the nozzle and finally degenerated into a perfect downpour of water. From this it appears that the current of steam assumes the shape of a cone, and in cylindrical or slightly conical stacks it impinges sharply against the sides, and is here partially condensed, and that a portion of the water that is mingled with the jet is also thrown against the sides. This contact gains in force the shorter the nozzle distance and the smaller the upper diameter of the stack, as compared with its total length measured from the nozzle. The greater the flare of the stack the later does the shower begin and the weaker it is, the smallest diameter remaining the same. For example, take a nozzle diameter of 4.74 inches, with a stack having an inclination of $\frac{1}{6}$ and a minimum diameter of 15.75 inches, with a nozzle distance of 3 feet 8.11 inches, and compare it with a stack having an inclination of $\frac{1}{12}$ and a minimum diameter of 29.92 inches. Table XXI. gives the results of such a comparison.

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen.*

TABLE XXI.

Stack diameters, inches	Nozzle locations in inches, at which the discharge of condensation was first observed, for nozzle diameters of									
	3.94 inches.		4.33 inches.		4.74 inches.		5.12 inches.		5.51 inches.	
	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination
11.81	18.90	23 62	18 90	22 05	18.90	18.90	18.90	18 90	18.90	18.90
12.80	22.05	29.92	20.47	26.77	18.90	22.05	18.90	20.47	18.90	18.90
13.78	26.77	36.22	25.20	33.07	20.47	26.77	18.90	25.20	18 90	23.62
14.76	33.07	40.94	29.92	39.37	23.62	33.07	18.90	31.50	18.90	28 35
15 75	39.37	47.42	36.22	45.67	29.92	44.11	23.62	42.52	18.90	40.94

Remarks: Cylindrical stacks of from 13.78 inches to 15.75 inches in diameter began to throw water at a nozzle position of 18.9 inches, but when the diameter was increased to 14.76 inches, the first water appeared at 20.47 inches, the nozzle diameter in both cases being 3.94 inches, and at 15.75 inches diameter with nozzles of 3.94 and 4.33 inches diameter water appeared at 22.05 inches for the first and 20.47 inches for the second.

It may be remarked, that, in consequence of faulty observation, the first appearance of water may possibly have occurred earlier here and there, than is indicated in this table.

In these experiments, that position of the nozzle was always recorded at which the first drops of water were thrown in a circle from the mouth of the stack. It was also recognized, that for a given stack, when this began, the diameter was already too small for the size of the nozzle or the nozzle distance was too great.

In order that we may obtain dimensions that are serviceable from Table XXI., we must always keep the nozzle below the point where water appeared, which means that we must choose a nozzle position for a lower efficiency than that given in the table. (The rules given in Section III. on the determination of the nozzle position supply values which underlie the tabulated figures.

Similar experiments conducted with locomotives show this throwing of water to be only occasional with small stacks, and even then it does not occur in any great quantity. The reason for this is simply that the current of steam is surrounded by an envelope of the hot products of combustion by which it is partially dried and by which the sides of the stack are also heated.

It was further shown that the same stack, which threw quantities of water from the apparatus, was even more strongly inclined to throw sparks from the locomotive. The latter may be taken to be due, in the first place, to the vacuum being too high, but it is also dependent upon the depth of the bed of the fire, the kind of fuel used (whether coarse or fine, smooth or gritty, wet or dry), also the size of the grates and the air passages between the bars; the number, diameter, and length of the tubes, and the running speed, all of which are matters of considerable importance; the reason for which is that because, in general, the faster the speed the weaker the impulse of each exhaust, although they follow each other with greater rapidity, therefore the draft is more even and gentle than where there is a greater interval between the impulses. But according to all observations the ratio existing between the stack and the nozzle exerts an influence of the first order. A stack that is too large relatively to the diameter of the nozzle cannot exceed and may not even equal the vacuum produced by a smaller stack and a larger nozzle.

A larger stack has a further advantage in comparison with a smaller one on account of its efficiency in tending to free the tubes from dirt, for, in raising steam in a locomotive, the products of combustion are more easily passed through it, and while running down long grades without steam with the engine reversed, the injurious sucking of the smokebox gases into the cylinder is greatly modified.

A connection between the water thrown from the apparatus and the sparking on a locomotive seems to lie in the fact that the water throwing was merely a characteristic of the stacks with which the experiments on the apparatus were conducted. If, under practically the same conditions, one stack gives a higher value for the vacuum than another, the first, regarded independently of the absolute size of the stack, is superior to the other from a practical standpoint, if it does not throw water from the apparatus or spark more or less upon the locomotive. From this we conclude that,

The absolute value of the vacuum is not the determining feature in settling the efficiency of the shape of the stack.

A few examples will assist in making this clearer:

1. As the first fruits of the experimental apparatus were produced we found that, with a nozzle opening of 4.74 inches and a location of 21.65 inches below the bottom of a stack having an inclination of $\frac{1}{12}$, the vacuum produced was superior to that of a stack having an inclination of $\frac{1}{6}$, a fact which was proved on a few

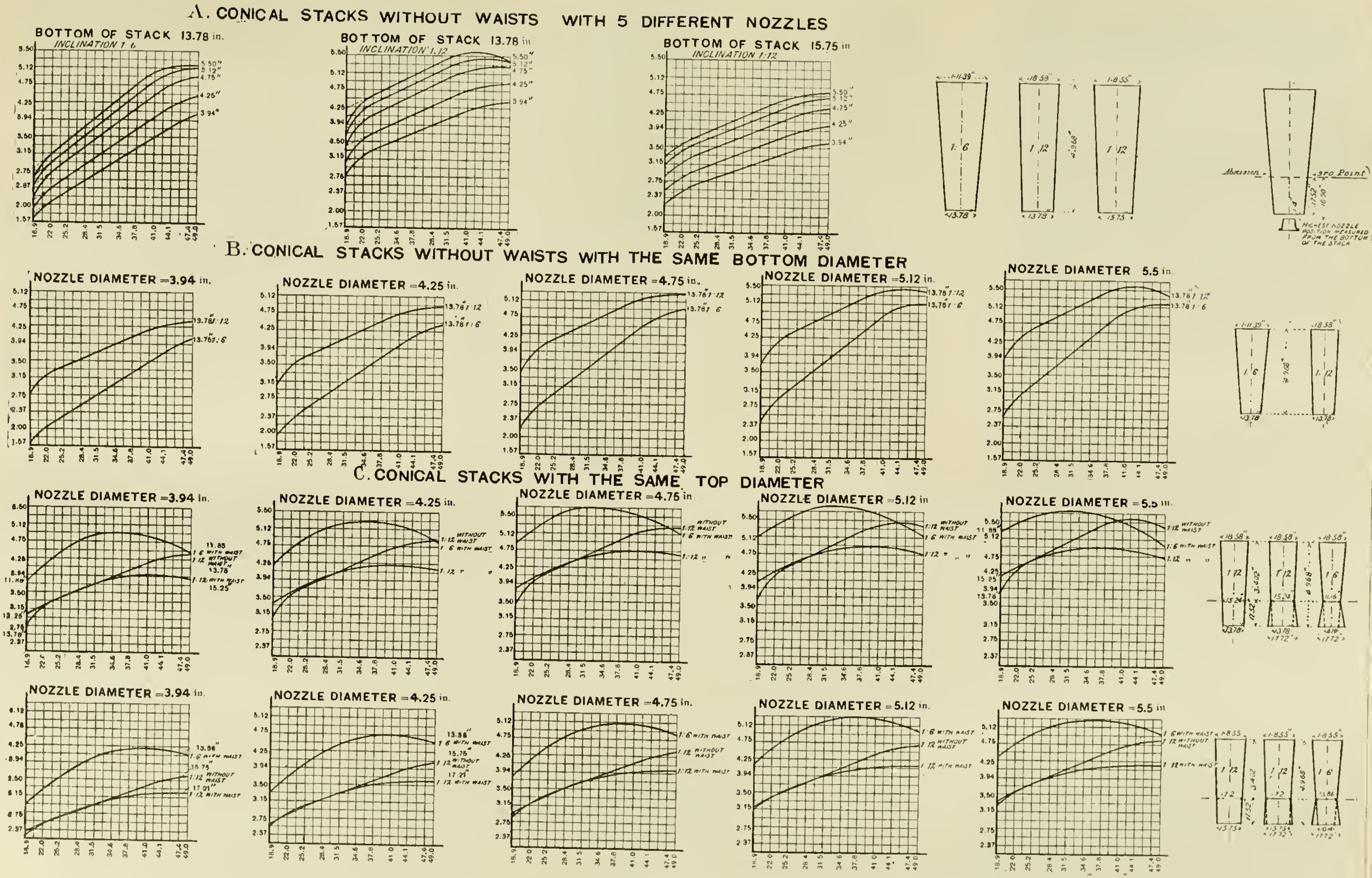


PLATE V.—DETAIL DIAGRAM OF THE HANOVER SMOKE-STACK AND EXHAUST NOZZLE EXPERIMENTS.

NOTE 1.—All observations with the water column were made with the same steam pressure (equal to 3.91 in. of mercury), and with exactly the same air openings.
2.—The abscissas (nozzle distances) are taken with stacks having no waist from a point 17.52 in. above the smallest section and 18.90 in. above the highest position of the nozzle.
3.—Curves of stacks 15.24 in.—1:12 (with waist) and 17.2 in.—1:12 (with waist), are taken by interpolation from Plate I.

locomotives in service. These had conical stacks, with an inclination of $\frac{1}{6}$, a diameter of 13.78 inches, a nozzle 4.74 inches in diameter, located 19.68 inches below the bottom. A sheet-metal lining with an inclination of $\frac{1}{12}$ was built into this stack of $\frac{1}{6}$ inclination on the locomotive, as shown by the dotted lines of Fig. 45. Then, instead of the efficiency rising, as would have been expected, it not only remained the same, but was accompanied by a few other circumstances. The locomotive exhibited a tendency to throw sparks and, according to the driver, an inclination to eject water as well. In consequence of this the lining was removed and it was decided to substitute for the lining with its $\frac{1}{12}$ inclination a stack of $\frac{1}{12}$ inclination and having a larger bottom diameter. Instead of 13.78 inches it was made 15.36 inches.

In the same way two express locomotives having nozzles 5.51 inches in diameter, located 19.68 inches below the bottom of the stacks which had a diameter of 15.75 inches and an inclination of $\frac{1}{5}$, were fitted with cylindrical linings. Although a higher vacuum was obtained with the cylindrical stack on the apparatus than with stacks of either $\frac{1}{6}$ or $\frac{1}{12}$ inclination, and consequently it would have made a similar showing with those of $\frac{1}{5}$ inclination, the lining was not kept upon either locomotive, since it developed the same peculiarities that the $\frac{1}{12}$ lining had in the stack of 13.78 inches diameter.

The reason for these failures was first shown at a later period, when the connection between the throwing of water on the apparatus and the sparking on the locomotive was discovered. We can now, without any further explanation, and with the aid of Plate II. and Table XXI., see that the stack of 13.78 inches diameter, an inclination of $\frac{1}{12}$ and a nozzle diameter of 4.74 inches, threw water when the nozzle distance was 20.47 inches, while, on the other hand, the one having an inclination of $\frac{1}{6}$ showed its first water at 26.77 inches.

In the same manner the cylindrical stack, 15.75 inches in diameter, threw water with a 5.51 inch nozzle located at 18.9 inches, and at the same point the conical stack, with an inclination of $\frac{1}{12}$, threw water and sparks, so that it is safe to consider that this will begin at shorter nozzle distance with the cylindrical stack, while a stack of $\frac{1}{5}$ inclination (drawing our conclusions from the performance of the one with $\frac{1}{6}$) neither throws water nor sparks at 19¾ inches. Hence, as we shall see later, it will not do to use a cylindrical stack of the same diameter as the smallest, having an inclination of $\frac{1}{5}$, but it should be somewhat larger, that is about 16.9 inches instead of 15¾ inches.

2. A few old Erfurt passenger and freight locomotives were in the main shops at Templehof and equipped with stacks like that shown in Fig. 46. These were replaced by others like those shown

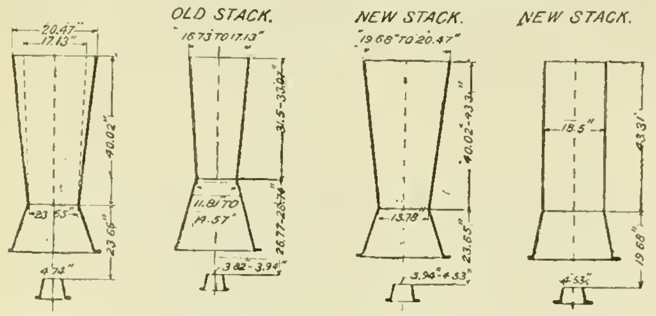
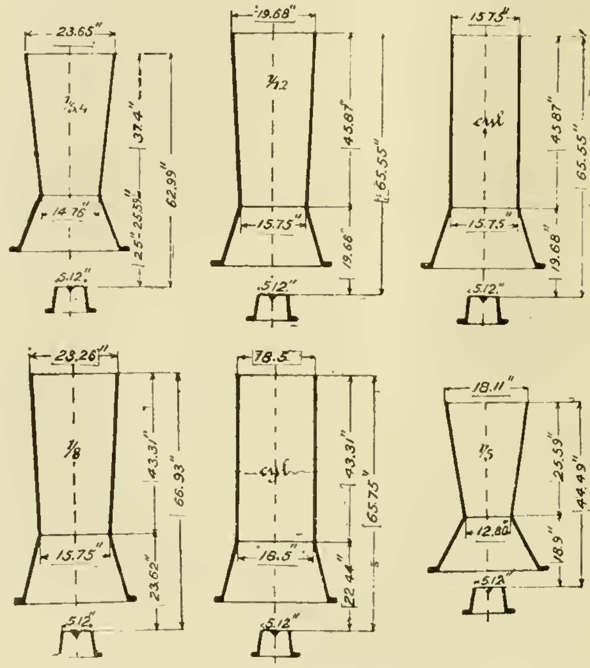


Fig. 45. Fig. 46. Fig. 47. Fig. 48.

in Figs. 47 and 48. The result was that the locomotives with the larger stack and shorter nozzle distance tore their fires very much less and were better steamers than before. Also in a few of these locomotives which had previously shown a tendency to heat the smokebox sheets to red heat, that difficulty was entirely overcome.

Table XXI. shows that the stack 11.81 inches in diameter, and having an inclination of $\frac{1}{6}$ with a nozzle 3.94 inches in diameter, threw water when the nozzle distance was 23.62 inches, and this would be even more likely to occur with the distance of 28.74 inches, as shown in Fig. 46.

3. The stacks of the new Erfurt passenger and fast freight locomotives have the dimensions given in Fig. 49. They are good steamers, and when working easily they throw no sparks, though they probably would with a later cut-off (25 or more). In order that the observations set forth in Table XXI. might be tested by actual locomotive service, five stacks were made in the last-named workshops, that are illustrated by Figs. 50 to 54, and in the winter of 1895 they were applied to two of these locomotives and tested under unfavorable conditions of weather with the same nozzles, which had a diameter of 5.12 inches, with a bridge .31 inches wide across the opening, thus making it the equivalent of a nozzle 4.94 inches in diameter. With the stack shown in Fig. 50 the locomotive steamed better than before, but it also threw more sparks. The latter feature was true to a still greater extent when they applied the cylindrical stack 15.75 inches in diameter, that is shown in Fig 51, which was on that account soon removed. The spark throwing diminished very considerably on the application of a waist of the same diameter in connection with a conical portion having an inclination of $\frac{1}{6}$, as shown in Fig. 52, and a cylindrical with a diameter of 18½ inches, as seen in Fig. 53.



Stacks of Erfurt Locomotives—Figs. 49 to 52.

The generation of steam with both stacks was also so good that the driver asked to have the experimental stack left upon the engine. Finally with the form illustrated by Fig. 54 the throwing of sparks reached its maximum. It was to have been foreseen that the stack in question should not give the best results, but rather serve as a proof of the assertions made above. On account of the small diameter of the waist it was necessary, according to Plate I, to diminish its length to 25.59 inches with a nozzle distance of 18.9 inches, thus making the total height 44.49 inches, with a very rapid flare, measurements chosen on the basis of Plates II. and III.

Throughout the fourteen days of the test, which was during an unfavorable condition of the weather, the stack caused the engine to steam well, but of all six of the stacks that were tried it threw the greatest quantity of sparks, as we have already said, as well as unburned particles of coal.

A comparison of the curves of this stack as shown in Plate II., in which we bring together and observe stacks with inclinations of $\frac{1}{5}$, 4, $\frac{1}{5}$ and $\frac{1}{6}$, and see that by the application of a bridge to the mouth of the nozzle the water throwing begins with a shorter nozzle distance than that given in Table XXI.; this comparison then gives the following results:

A stack of 14.76 inches diameter, with an inclination of $\frac{1}{6}$, and a nozzle distance of 25 inches, threw no water.

A stack of 15.75 inches diameter, with an inclination of $\frac{1}{12}$ and a nozzle distance of 19.68 inches, threw water.

A stack of 15.75 inches diameter, cylindrical in form, with a nozzle distance of 19.68 inches, threw water.

A stack of 15.75 inches diameter, with an inclination of $\frac{1}{8}$ and a nozzle distance of 23.62 inches, threw no water.

A stack of 18.5 inches diameter, cylindrical in form, and a nozzle distance of 22.44 inches, threw no water.

A stack of 12.8 inches diameter, with an inclination of $\frac{1}{5}$ and a nozzle distance of 18 9 inches, threw water.

The three water-throwing stacks here indicated are the same that upon locomotives in service, threw the most sparks, and which were also the ones that began throwing them the first, while, with the other three stacks, the opposite set of conditions prevailed.

A connection between water-throwing on the apparatus and spark-throwing on the locomotive has, therefore, been demonstrated to exist beyond all peradventure.

(To be Continued.)

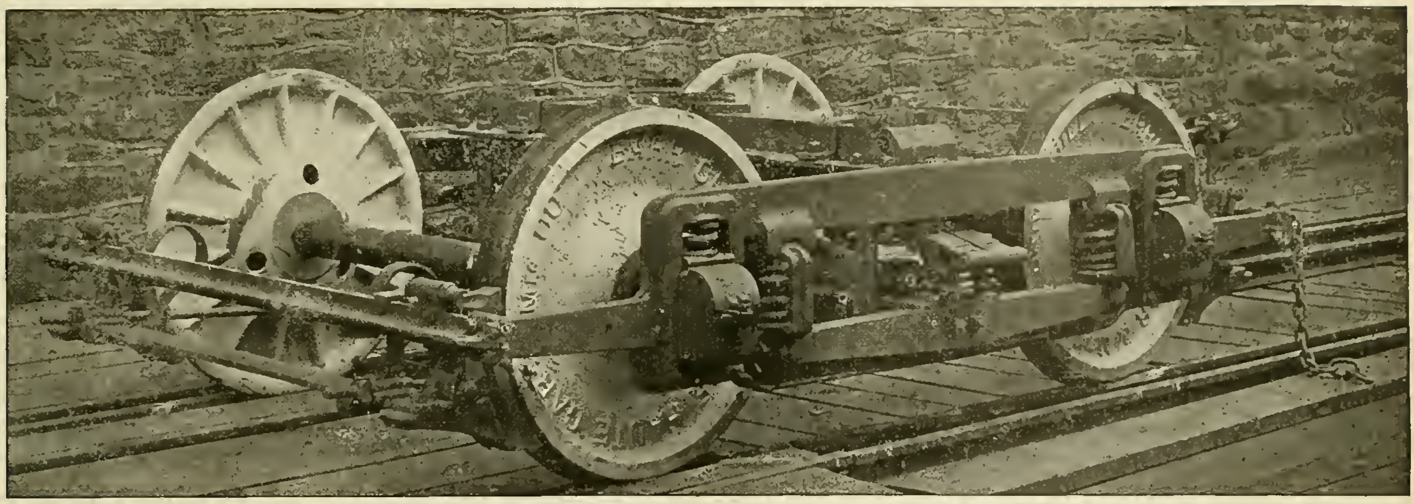


Fig. 1.—Perspective View of the Brill Passenger Truck.

A "Perfect" Truck for Passenger Cars.

During the recent conventions, which were held at Saratoga, Messrs. J. G. Brill & Company, of Philadelphia, exhibited a very well made model of a new truck which they are now introducing on steam and electric roads, and which has some novel features, and for which some important advantages are claimed.

Fig. 1 represents a prospective view of one of these trucks, Fig. 2 is a side view, drawn in outline, Fig. 3 a diagrammatic cross-section, and Fig. 4 a view of an elastic swing-hanger, which is one of the peculiar features of the truck.

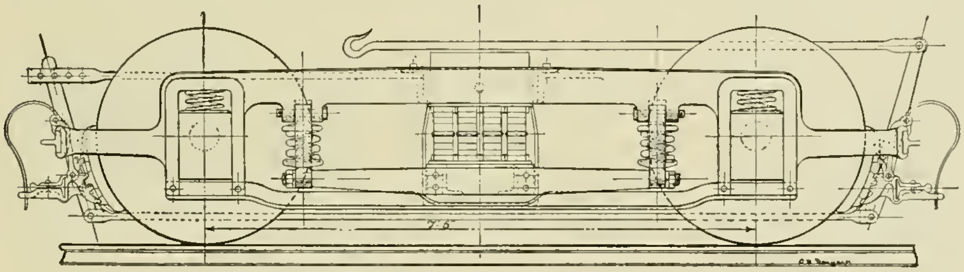


Fig. 2.—Side View of Brill Passenger Truck.

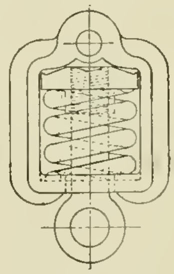


Fig. 4.—Elastic Swing Hanger.

The principle of the construction of the frame resembles that which has so long been adopted for locomotive frames. For steam cars they are forged, and for electric roads they are cast of steel.

The top bar or wheel piece consists of a single bar, which extend-from one of the journal boxes to the other, as shown in Figs. 1 and 2. On this bar jaws are forged or cast to receive the journal boxes and on the outermost ones an extension is added to which T-iron end pieces are bolted, which connect the two frames together, and from which the brake beams are suspended. The upper or main bar of the frames have lugs forged on them between the jaws and as near to them as may be practicable. To these the swing links are attached. These are of a somewhat peculiar construction, which is shown clearly in Figs. 1 and 4. They each consist of an open cast-steel stirrup, which receives an eight-inch spiral spring, having a follower nut on top, into which an eyebolt is screwed, the lower end of which is connected to the equalizing lever. The stirrup has an eye in its upper end, by which it is attached by a bolt to the lugs on the wheel piece. The weight which is carried by the equalizer is transmitted to the eyebolt and thence to the spring, which acts as an elastic bearing, at the same time the stirrup can swing laterally on the bolt which passes through its upper end, as indicated on the left side of Fig. 3. The equalizers are made with pivotal ends, which enter the eyes on the lower ends of the stirrups.

The spring-plank consists of two Z-shaped bars, shown by dotted lines in Fig. 2, and filled with wood. These are rigidly fastened to the equalizers, which can swing on the stirrups or links, and the spring-plank moves with it. The transoms consist of angle-iron bars, which are fastened to lugs on the forged frames, but in the cast-steel frames are fastened by angle plates, one of which is shown between the two front wheels in Fig. 1. The interior springs are double elliptics, but, of course, spiral springs could be used if it was thought desirable to do so. Two, three or four such springs may be used on each side.

From the description it is obvious that the spring-plank and equalizers can all swing laterally in the stirrups, which form spring swing-links. The load rests primarily on the interior elliptics, or whatever kind of springs are used in that position. It is then transmitted to the spring-hangers, and from them to the journal springs. This gives a very great degree of elasticity to the truck, and enables it to adjust itself with a minimum amount of disturbance to the inequalities of the track. The equalizers have also the effect of distributing the load equally on the two wheels on each side of the truck, no matter what the vertical position of any of the wheels may be.

Owing to the fact that the load primarily rests on the equalizers, and by them is transmitted to the main frames at points close to

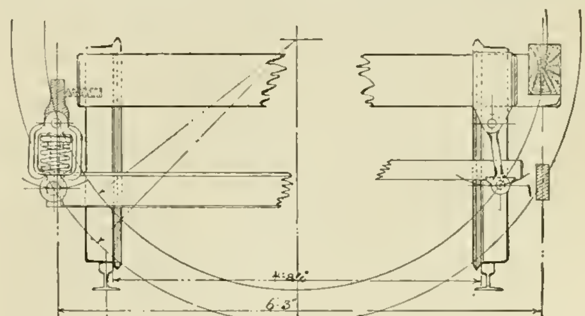


Fig. 3.—Brill Passenger Truck.

the jaws, these frames are subjected to less strains than they would be if the load rested on them about midway between the wheels. The T-iron end pieces and the attachment of the transoms to the wheel pieces or side frames affords a very effective means of holding the truck square.

The result of the lateral and vertical adjustibility of these trucks is that they are reported to have great "adherence" to the track that even on very rough roads they have been found to be safe, and to ride with great ease and comfort to passengers. Messrs. J. G. Brill & Company, the well-known car builders of Philadelphia, are the sponsors for this truck, and are now supplying it for both steam and electric roads.

The Railroad Master Blacksmiths' Association.

The annual meeting of the National Railroad Master Blacksmiths' Association will be held at Chicago, beginning at 10 o'clock, Sept. 1, 1896, at the Tremont House. A specially interesting programme of pertinent topics has been prepared. Arrangements have been made whereby they secure a rate of $2 per day at the Tremont House, which will be official headquarters. It is located on the corner of Lake and Dearborn streets, Chicago. Members will kindly notify Mr. John Buckley, of the Illinois Central Railroad shops, Chicago Ill., whether they intend to attend the convention, also if they are going to be accompanied by members of their family, and how many. This will give Mr. Buckley an opportunity to make proper arrangements with the manager of the Tremont House.

The Origin of Pneumatic Tires.

In an article in the *Indiarubber World* Hawthorne Hill says: One can readily believe that the attention of visitors to the fashionable parks in London, at a certain period just a half-century ago, was "much attracted" by the appearance among the gay equipages of a certain brougham, after reading the contemporary descriptions of the latter. The vehicle had been constructed without springs, but its chief novelty lay in certain "improvements" patented by a civil engineer of Middlesex County, named Robert William Thomson, in the shape of what he called "noiseless tires." They were, in fact, the pioneer pneumatic tires, and the inventor had boldly started out to exhibit them on the wheels of a brougham weighing nearly 1,200 pounds. The present time marking, as it does, the semi-centennial of so many important applications of indiarubber, seems a proper occasion for recalling Thomson's "patentaerial wheels," though it is not proposed to connect their invention, by any link, with the pneumatic tires which have become so successful.

"The nature of my invention," says Thomson in his specification, No. 10,990 of 1845, "consists in the application of elastic bearings round the tires of wheels of carriages, rendering their motion easier, and diminishing the noise they make while in motion. I prefer employing for the purpose a hollow belt composed of some air-tight or water-tight material, such as caoutchouc or gutta-percha, and inflating it with air, whereby the wheels will in every part of their revolution present a cushion of air to the ground, or rail, or track, on which they run."

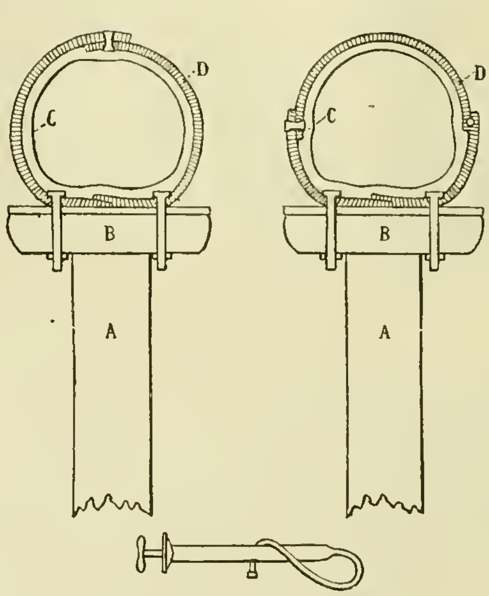
This elastic belt, as Thomson called his inner tube, was composed of several thicknesses of canvas, each "saturated and covered on both sides with indiarubber or gutta-percha in a state of solution," laid one upon another, and each "cemented to the one immediately below it by a solution of indiarubber or gutta-percha, or other suitable cement."

How the edges were joined to complete the belt as a tube is not mentioned.

But it was the outer casing or cover that first caught the public eye, and to understand its construction one must refer to the drawings. *A* represents the end of a spoke; *B* is a section of the wooden felloe, much broader than usual, and tired with steel; *C* is the inner tube, and *D* is the leather shoe. The latter was built upon the wheel by attaching two long strips of leather to the whole circumference, with bolts inserted through the felloe and steel tire at every few inches. The outer edges of these strips were brought together over the inner tube and riveted together, after which the tirewas complete.

Or a third strip of leather might be used, as shown in the drawing to the right, being riveted to one of the base pieces and laced to the other. A pipe through which to inflate the inner tube was passed at one place through the tire of the wheel, and fitted with an air-tight screw cap. In the lower drawing is shown the "condenser" used for inflating the tube. It was the size of Thomson's tires, next to the noiselessness of the wheels, that most attracted attention. They were about 5 inches in diameter, intended to be so inflated as to keep the tire of the wheel $2\frac{1}{2}$ inches from the ground, which was thought to be "sufficient to admit of the wheels passing over any stones or other matters projecting beyond the general level of any ordinary turnpike road without the solid tire coming in contact with them. Wagons for the carriage of goods were expected to need tubes of a larger diameter and stronger materials.

In commenting upon the new-style of wheels, the *Mechanics' Magazine* (London), after the trial brougham had been drawn upward of 1,200 miles, without "the slightest symptoms of deterioration or decay" in the tires, had this to say: "It has so long been regarded as a settled thing that friction is least with hard substances and greatest with soft, that by a natural, though not perhaps strictly logical, course of induction we inferred that, though in this case the noise might be less, the friction, and consequently the tractive power required, would be greater. We must candidly own that we little expected to find the very reverse of this to be the fact. Yet so it is." Then are given the results of experiments made with Thomson's wheels in the Regent's Park by a noted firm of coach-builders, and verified by the editor,



T omson's Pneumatic Tires.

showing the comparative lightness of draught of the "aërial" wheels, both on a smooth and firm road and on a section covered with newly broken stone.

The table follows, showing draught in pounds:

	Common wheels.	Patent wheels.	Saving by pt. wheels per cent.
Over smooth, hard road	45	28	60
Over new broken flints	120	38½	301

Evidently our pioneer inventor had given much thought to his work, for in his specification he treated at length of the variations possible in the construction of the pneumatic tire, in order to make the patent as "broad" as possible. Some of it is good reading, too, as showing the ideas he entertained with regard to the properties of air in wheel tires.

One variation of Thomson's original suggestion of an inner tube was that several tubes might be employed for a single tire—up to nine, for instance. In such cases the ordinary air-pipe would have to be dispensed with, the inflation being accomplished by means of air-screws in one end of each tube before they were laced into the leathern envelope. It was suggested that the leather might be protected from wear by covering its outer surface with flat-headed metal rivets secured on the inside with small washers.

The latter end of the "aërial" wheel is not certainly known, but tradition has it that its inventor was much laughed at. Six years after the date of his pneumatic tire patent, Thomson's name appeared in the catalogue of the Great Exhibition of London in connection with an invalid chair, of which "the wheel (in addition to an iron tire) is shod with a solid band of vulcanized indiarubber, said to be as durable as iron." As late as 1868 all the scientific journals in Europe were describing Thomson's solid indiarubber tires (5 inches thick) for traction engines for common roads.

The Freezing of Gas.

Since gas began to be adopted generally for lighting purposes it has been the aim of gas engineers to prevent the freezing in of gas pipes. Until recently it has been the general opinion that the moisture always present in lighting gas caused the freezing in by its separation in frost-like form, and all the methods known so far to prevent this are based upon the principle of removing the moisture in the gas before its entrance into the conduit pipes. The method formerly employed to reach this purpose was that the gas was exposed in so-called "freezing-out" cylinders to the cold, whereby, of course, the drying of the gas was obtained. But, as in the freezing-out cylinder, not only the moisture contained in the gas, but also large quantities of the light-giving carburated gases were separated, the frozen out gas showed such losses of lighting power that the practical employment of this method was hardly possible.

An extraordinarily simple and cheap method to dry the lighting gas by means of sulphuric acid of certain concentration was patented by the German Continental Gas Company two years ago, and proved quite satisfactory in the beginning. In the last hard winter, however, the chandeliers and conduits froze in again, although the gas entered the distributing pipes entirely free from water, and an investigation showed that the pipes were perfectly stopped up by frost-like formations in the same manner as if undried gas had been used. There was only the difference that these formations did not consist of frozen water, but of frozen, almost chemically pure, benzol.

This discovery shattered at once the former opinion that the freezing in of the pipes was caused by moisture contained in the gas, and the author very soon discovered a method by which not only the freezing of the moisture, but also that of the benzol was made impossible. The principle of this method is, that in the gas works and behind the gas meter, a certain quantity of alcohol vapor is added to the gas. The effect of this alcohol vapor is shown in the fact, that, if, by the action of the cold, separations of water and benzol occur, the alcohol vapor carried along also separates, whereby the freezing point of these separated condensations of water and benzol is forced down so much, that they will not congeal even at our coldest temperature in winter, but remain in liquid condition. They can, therefore, flow back into the main conduit and from there into the next condensing pot. A stopping up of the gas conduit by separation of solid condensations is made impossible in this manner.

The action of the alcohol vapor added to the gas is here an altogether different one of that caused by injecting liquid alcohol into frozen-up pipes. By my method a means is furnished to prevent freezing in altogether, while in the former use of alcohol in the gas works it was but intended to thaw up conduits that were frozen in already.

In the last hard winter it was shown by experiments that the action of the alcohol vapor added at the gas works is still effective at a distance of three miles—that is, the alcohol vapor remains in the gas. The action of the alcohol vapor, however, is stopped as soon as the gas has passed a wet gas meter. In the case of large establishments a small apparatus for evaporating alcohol can be provided behind the gas meter.

For practically carrying out this method a small evaporator of ordinary construction heated by steam, or a little gas flame, is used, into which the alcohol from a higher placed tank flows in a fine, instantly evaporating stream. The hot alcohol vapor is conducted through a little pipe into the gas main and at once absorbed by the gas.

In order to obtain the desired effect about five grammes of 95 per cent. denaturated alcohol must be added per one cubic meter; at very low temperature, about 10 to 20 degrees below zero, this amount must be increased by one or two grammes. In most cases it is sufficient to commence with evaporating alcohol about half an hour before the street lamps are lit, while the addition of alcohol in the day time would appear to be necessary in exceptional cases only.

This method was employed on a large scale last winter in the gas works at Dessau, where it has given excellent results. Its advantages must not be looked for in the saving of alcohol; on the contrary, in most cases more alcohol is consumed than in the old method, which aimed only at the removal of obstructions produced by freezing it. The great advantages of the new method are found in the saving of wages, and, above all, in the entire removal of interruptions in the distribution of gas, which usually occur when most disagreeable—that is, in the winter, and which are apt to discredit gaslighting during that season.—*Exchange.*

Tests of Boilers.

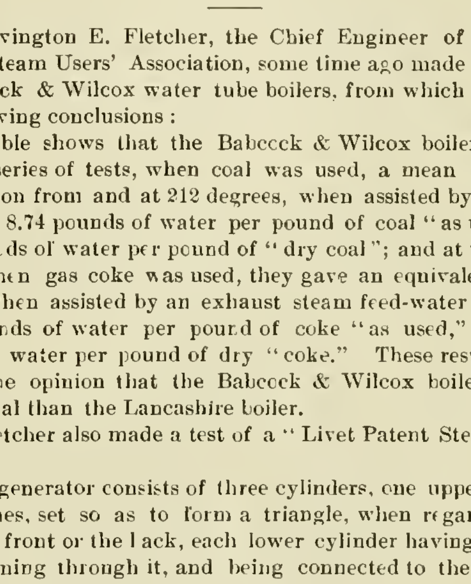
Mr. Lavington E. Fletcher, the Chief Engineer of the Manchester Steam Users' Association, some time ago made some tests of Babcock & Wilcox water tube boilers, from which he draws the following conclusions:

The table shows that the Babcock & Wilcox boilers gave, in the first series of tests, when coal was used, a mean equivalent evaporation from and at 212 degrees, when assisted by an economizer, of 8.74 pounds of water per pound of coal "as used," and 9.29 pounds of water per pound of "dry coal"; and at the second series, when gas coke was used, they gave an equivalent evaporation, when assisted by an exhaust steam feed-water heater, of 9.02 pounds of water per pound of coke "as used," and 10.07 pound of water per pound of dry "coke." These results do not justify the opinion that the Babcock & Wilcox boiler is more economical than the Lancashire boiler.

Mr. Fletcher also made a test of a "Livet Patent Steam Generator."

"This generator consists of three cylinders, one upper and two lower ones, set so as to form a triangle, when regarded either from the front or the back, each lower cylinder having a furnace tube running through it, and being connected to the upper one by a series of conical pipes. (See Figure.)

"In the generator tested by the M. S. U. A., which was a new one, the upper cylinder was 6 feet 6 inches in diameter, and the



Livet Steam Generator.

two lower ones 5 feet 9 inches in the shell, all three cylinders being 24 feet 6 inches long as nearly as may be. Each furnace tube was 3 feet 6 inches in diameter, and fitted with six conical water pipes, while the fire grates were 6 feet long by 3 feet 5 inches wide, giving an area of 41 square feet. In addition to the three cylinders just described, there were three smaller ones placed in the external brickwork flues, two of them being 25 nches in diameter, and the third 30 inches. Through these cylinders the feed water was passed and heated before entering the upper cylinders of the generator.

"The tests were made at atmospheric pressure, all the steam passing away at the manhole, which was wide open."

From the tests it appears that no decided economy attends the use of the Livet patent steam generator, the equivalent evaporation from and at 212 degrees per pound of "dry" coal at tests No. 1 and 2 being 9.66 pounds, which is not superior to that obtained by boilers of the Lancashire type when worked under ordinarily fair conditions.

Further, the Livet steam generator requires a greater width of frontage than the Lancashire boiler. Taking the width from center to center, in a range of Livet steam generators, at 17 feet, and that in a range of Lancashire boilers 8 feet in diameter, at 11 feet, it works out that the Livet steam generator would evaporate 402 pounds (6.4 cubic feet) of water per foot width of frontage, and the Lancashire boiler 622 pounds (0.9 cubic feet). Converting this into power, at the rate of 20 pounds of water per independent horse power, it works out that the Livet steam generator would develop 20 independent horse power per foot width of frontage, and the Lancashier boiler 31 independent horse power, so that a Lancashire boiler develops 50 per cent. more power per given width of frontage than the Livet steam generator.

The M. S. U. A. would decidedly recommend the adoption of a Lancashire boiler, having a length of 30 feet, with a diameter of 8 feet 6 inches in the shell, and 3 feet 6 inches in the furnace tubes, for burning refuse fuel, in preference to a Livet steam generator.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

Evaporative Test on Three Sterling Boilers at the Waltham Bleaching and Dye Works. Waltham, Mass. *Dean & Main and D. P. Jones, Engineers.* Published by the Sterling Company, Chicago, Ill. 8 pages, 5¾ by 8½ inches. (Not standard size.)

In this test an evaporation of 13.03 lbs. of water per pound of coal is reported, which, of course is very good and accounts for its publication by the Sterling company.

Comparative Test Made by the Pittsburgh Testing Laboratory, Limited, *for Carrie Furnace Company.* Pittsburgh, Pa.

This report is issued by Messrs. H. E. Collins & Co., of Pittsburgh, who apparently are the agents or manufacturers of the Cahall water-tube boiler. The test, of course, showed to the advantage of the Cahall boiler, otherwise, it would not have been published by this firm.

Schoen Pressed Steel Company, Pittsburgh, Pa. 16 pages, 7¾ by 10½. (Not standard size.)

The purpose of this publication is to describe the Schoen Pressed Steel Truck Frame, which is a specialty of manufacture by this company. It is illustrated by outline and perspective veiws which show all the details of construction very clearly. This truck frame belongs to the class which are made of plate steel flanged and formed into the required shapes, and which are now being very extensively introduced.

An Illustrated Description of a New Driver Known as the Lidgerwood Rapid Unloader, Used for Unloading Dirt, Ballast, etc., From Flat Cars in Railroad Works. *Lidgerwood Manufacturing Company.* New York. 32 pages, 5½ by 9 inches. (Not standard size.)

The title of this pamphlet indicates its character. In it the arrangement for unloading cars is illustrated with a number of half-tone engravings and its construction and operation is described quite fully.

Lidgerwood Cableways, Hoisting and Conveying Devices. *Lidgerwood Manufacturing Company.* New York, 110 pages, 5¾ by 9 inches.

This is quite an elaborate treatise on the class of machinery which it is intended to describe. With many illustrations and descriptions of the various appliances and their details which are in use. Some illustrations made from photographs of machinery used in the Chicago Drainage Canal are very interesting and give an idea of the magnitude of that great work.

The Jeffrey Labor Saving Appliances. *The Jeffrey Manufacturing Company.* Columbus, Ohio. 5½ by 8 inches. 60 pp., (Not standard size.)

The safety appliances referred to in this title are: Chain Belting, Elevators, Conveyors, Carriers, Steel Cable Conveyors, Power Transmission Machinery, Mill, Factory and Mine Supplies and Mining Machinery. Many illustrations of such "plants" are given in the book must of which are half-tone engravings made from photograph, although some of the details are shown by wood engravings. The whole "get-up" is very neat and effective.

Introducing the Stratt n Combined Separator and Steam Receiver. *The Goubert Manufacturing Company, New York.* 8 pp. 6 by 9 inches. (Standard s ze.)

The first word of the title of this pamphlet indicates that it was published for some special purpose, and not as a complete description of the device to which it refers. It opens with an excellent description of what the Stratton Separator is, and then describes the fall of pressure which occurs between the boiler and the engine, and how it is obviated by placing a receiver between them. The purpose of the pamphlet apparently is to show how the appliance described serves the purpose of both a separator of moisture from the steam and a receiver. For a description of the device the reader is referred to a treatise on "Dry Steam the Foundation of Economy," which has been issued by the company.

The illustrations, printing and paper are all excellent.

The "Thornycroft" Water-Tube Boilers. *Messrs. John Platt & Co., Agents.* New York. 8 pages, 7¼ by 9¾ inches.

Messrs. Platt are the agents in this country for the Thornycraft boiler, which is better known in Europe than it is here. There it has been applied to a great many ships; more than 200,000 horse power are said to be in use. In the pamphlet its advantages are set forth very concisely, and illustrations are given showing the different types and describing their uses.

Another four-page pamphlet of nearly the same size is sent with the first one, in which the Thornycroft automatic field regulator is illustrated and explained. This is an important adjunct to water-tube boilers, and seems to be essential to their satisfactory working.

Catalogue of the Cleveland Twist Drill Company, *Manufacturers of Increase Twist Drills, Self-Feeding Reamers, Taps, Cutters, etc.* 1896. 62 pages, 6 by 9 inches. (Standard size.)

As the name of this company indicates, one of its leading productions is twist drills, and these are found in every conceivable style in this catalogue. The list includes those with straight, taper and square shanks, drills with straight and with spiral flutes, drills with oil-feeding ducts or tubes, drills for machinists' and blacksmiths' drill presses, wood bitts for braces and for machines, drills in English measurements and in millimeter sizes, and for many special requirements. The company's grip socket, which embodies a great improvement in the method of driving taper shank drills and other tools, is also illustrated. Boring bars, drill holders, steel sockets for drills, center reamers, nut taps, staybolts and other boiler taps, arbors and mandrels, shell reamers, self-feeding and expansion reamers, chucking and taper reamers of all kinds, end mills and milling cutters, are among the many useful tools illustrated in this catalogue. The company also make twist drill grinding machines of various sizes. Of the goods mentioned many sizes are carried, and the company is also ready to consider the construction of special tools, correspondence concerning which is solicited. The catalogue is very neat in appearance. A copy of it will be sent to any of our readers upon written application to the Cleveland Twist Drill Company, Cleveland, O.

Ferracute Machine Company, Presses and Dies, Bridgeton, N. J. 32 pages 7 by 10 inches. (Not standard size.)

This catalogue has the peculiarity that all the leaves in it are twice the size of the cover and are folded inside of it, which seems to be an excellent plan where it is desirable to get a large page and yet keep the size of the book within reasonable limits. The company makes foot and power presses, lathes, beaders, dies, etc., for working various kinds of bar and sheet metals, which are very fully illustrated in the catalogue before us.

DESCRIPTIVE CATALOGUE OF THE INSTITUTE FOR HOME STUDY OF ENGINEERING AND OF ELECTRICAL APPARATUS FOR ITS STUDENTS. *The Scientific Machinist Company, Cleveland, O.* 48 pages, 6¾ by 10 inches. (Not standard size.)

Competition has invaded the educational institutions as well as other industrial fields. There are now several rival "Home Study" institutions to enable students who cannot attend a school to pursue a course of study at home, and who can be helped in so doing by correspondence with a school which has a staff of instructors. The publication before us gives a description of the methods employed by the Cleveland school, which has been organized as a sort of annex to *The Scientific Machinist*, a paper published in that city, Doubtless many young men who are unable to have any other technical educational advantages may derive much advantage from the system of correspondence which has been organized in this and other schools.

THE ASHTON VALVE COMPANY. Boston. 80 pages. 6 by 9 inches. (Standard size.)

This company manufactures safety valves, steam gages and other kindred appliances and has just issued a new and handsome catalogue. Its frontispiece is a view from a photograph of the works of the company in Boston. Following this is an excellent portrait of the late Mr. Ashton, the founder of the company, whose well-known face was missed at the railroad convention this year, as he had been a constant attendant at these meetings for a great many years.

The illustrations of the articles manufactured by the company are excellent wood engravings and the typography, paper and press work are in excellent taste. The products of the company include the Ashton lock-up pop safety valves for different classes of boilers, water relief valves, shifting relief valves, car-heater valves, mufflers for safety valves, blow-back pop safety valves for locomotives, steam gages and pressure gages for a variety of purposes. Besides these articles the company makes a variety articles which are collaterally related to the principal departments of its business. The publication ends with a good index, which must be commended.

CATALOGUE AND PRICE LIST OF THE ARMSTRONG MANUFACTURING COMPANY, BRIDGEPORT, CONN.; *Water, Gas and Steamfitters' Tools and Machines for Cutting Off and Threading Pipe.* 1896. 50 pages, 5 inches by 6¾ inches. (Not standard size.)

This catalogue contains descriptions and prices of the well-known Armstrong pipe stocks and adjustable dies in various sizes. The largest of these will thread 4-inch iron pipe. They also make stocks and dies for bolts and for brass pipe. A new feature of this latest catologue is the pipe threading and cutting-off machines, of which the smaller sizes are made for either hand or power. All the driving gears are enclosed in an oil chamber, which keeps out dirt and chips and insures good lubrication. The largest size will cut off and thread pipe from 1 inch to 6 inches in diameter. The company also makes a full line of vises, including combination, plain and hinged vises, and vise jaws for brass pipes. They also make Armstrong pipe cutters, pipe wrenches, taps and tap wrenches, lathe dogs, machinists' and carriage makers' clamps and many other useful tools. The New York office of the company is at 139 Centre street.

THE STOW MANUFACTURING COMPANY, *Inventors and Manufacturers of the Stow Flexible Shaft.* Binghamton, N. Y. 40 pages. 6 by 9 inches. (Standard size.)

The Stow flexible shaft is so well known that it is not necessary to give any description of it, but this catalogue contains many interesting pages, illustrating the various uses to which it can be put, and the company manufactures the attachments needed for special work. So general has the use of flexible shafts become that the company has demands for them from nearly all trades and lines of work, including bicycle builders, instrument makers, door and blind manufacturers, surgeons, dentists, etc., etc. To meet special requirements they have been made to run at speed as high as 17,500 revolutions, and there is now quite a demand for waterproof shafts, which the company has successfully met. Among the many neat devices manufactured by the concern for use with these shafts might be mentioned breast drills, portable drills, pedestal drills, track and "corner" drill presses, tapping and reaming machines, universal joints, countershafts and pulleys for rope drives, portable emery grinders, clutches, spindles, ring grinder, and drill and reamer sockets. They also turn out portable electric motors, fitted with flexible shafts, and their radial flexible drilling machines, which consist of a radial belt drive for the shaft, attached to the ceiling or any suitable overhead structure, will drill a 2-inch hole anywhere within a 21-foot circle without occupying any floor space when not in use.

The company is ready to give its patrons the benefit of its experience in special work and invites consultation where parties have an idea that their wants can be met by any special adaptation of the flexible shaft or its fittings. The catalogue itself is very instructive in this respect and will repay a careful perusal.

DESCRIPTION, METHOD OF OPERATION AND MAINTENANCE OF THE VAUCLAIN SYSTEM OF COMPOUND LOCOMOTIVES. The Baldwin Locomotive Works; Burnham, Williams & Company, Philadelphia; 79 pages; 6 by 9 inches. (Standard size.)

This is a new edition of a pamphlet issued for a similar purpose some years ago, but which has been entirely rewritten, and containing many new engravings of locomotives not heretofore published. It opens with a statement of the aim of the inventor in designing the system of locomotives described therein. The principal features of the compound construction are then described, with an explanation of the action of the steam in the cylinders. To make this clear engravings are given of the cylinders, steam chest, bushings, pistons, valves, diagrams of the valve-gear, valve-stem guide, crosshead, piston, starting-valve and its arrangement. The operation of the engine and the method of running it are next described, and its various advantages are set forth. An interesting diagram is given showing the water consumption of simple and compound locomotives at various points of cut-off. A separate division is devoted to the methods of making repairs of these parts of this type of locomotives, which differ from simple engines. The methods of reboring, renewing and removing the bushings of the steam-chests for the piston-valves—which are used on these engines—is described with illustrations of the apparatus employed and its application to the engines.

In the form of addenda an explanation is given of how fuel economy is effected and the water consumption calculated, and also how the indicator diagrams from the cylinders can be combined to show the action of the steam in the cylinders to best advantage. A list shows that up to date 615 locomotives of this system have been built or ordered of the Baldwin Locomotive Works, which is probably a larger number of compound locomotives than have ever been built by any other establishment in the world. The volume concludes with brief reports of various tests which have been made on different roads with compound and simple locomotives.

Besides the text and various illustrations of details there are 95 engravings of different classes of locomotives illustrated by halftone engravings made from photographs. These illustrations are of varying degrees of excellence, some being very good and others not so good. Almost all classes of locomotives used in this country and some for foreign lands are included in these illustrations. Among them are tramway motors, locomotives for suburban traffic, for rack mountain roads, single wheel, American and Columbian passenger locomotives, moguls, ten-wheelers, consolidation and decapod engines—all of the Vauclain four-cylinder compound construction.

The letterpress is printed in brown ink, but the engravings are black. The paper and topography are excellent, and the volume is bound in a drab-colored paper cover; it may be presumed to ndicate its Quaker origin.

MANUAL OF THE SELF-ACTING INJECTOR OF 1887. Wm. Sellers & Co., Incorporated. Philadelphia; 24 pages 6 by 9 inches. (Standard size.)

The title of this catalogue indicates its general character. It illustrates, describes and sets forth the advantages of the form of injector which was brought out by this company in

1887. The illustrations are excellent wood engravings, representing sections and outside views of the different patterns which are made. The opening page gives a "Brief History of the Injector," which is so concise that there is room to quote it entire.

"The injector," it is said, "was invented by Giffard in 1850, and patented by him in France eight years later. In 1860 it was introduced in this country by William Sellers & Co., and the manufacture of it commenced at their works in Philadelphia. The early form of the injector was provided with adjustments for both the water and the steam, and the fact that many of these instruments are still in use attests the advantages of this arrangement. The necessity of frequent adjustment of the water ram led to the invention of the movable combining tube, which automatically regulated the water supply to suit all changes in the pressure of the steam. From this form was developed the Sellers self-adjusting injector of 1876. To simplify the operation of starting and to render the action of the jet positive under the most adverse conditions, automatic starting and a new system of automatic adjustment of the water supply were combined in an injector in which all the nozzles were fixed, the self-acting injector of 1887."

This latter is the instrument described in the catalogue which is before us, the opening page of which gives a statement of "convincing reasons why the self-acting injector of 1887 is better adapted to economical high-pressure locomotive service than any other injector." These "reasons" are followed by a description of its construction and operation. A table of sizes, capacities and prices follows this, after which there is a list of names of parts which are designated by numbers in a sectional view. The following pages give "hints" when the injector will not lift and when it will lift but will not deliver the water into the boiler, and miscellaneous suggestions with reference to the operation and repair of the injectors. In the last part the angle and check valves, which are used with these instruments, are illustrated and described. All the engravings are excellent and are made on wood, and are specimens of the art by which machining may be represented more satisfactorily than by any other now known, notwithstanding all the inventions made in that direction during the last quarter of a century.

ROBINSON RADIAL TRUCK. The Robinson Electric Truck and Supply Company, Boston. 20 pages, 7 by 9¼ inches. (Not standard size).

The Robinson Radial Truck, it is said, in the introductory chapter before us, "consists essentially of three flexibly connected single steel axle-frames, each containing one pair of wheels. The end frames are pivotally connected to the car body, while the intermediate frame travels between guides, transversely across the car-body, thereby causing the axles to become radial on curves and parallel on straight lines." This truck belongs to that class in which the frames which carry the end axles are connected to the car body by center pins, about which they can turn. The middle axle—there are three—is attached to the body so that it can move transversely to it. The frames of the end axles are also connected to the middle one in such a way that any transverse movement of the latter will turn the former about their center pins. By this means the three axles are made to assume a position radial to curves.

The pamphlet before us is well illustrated with outline drawings, showing the construction and arrangement of the trucks, and also with half-tone engravings made from photographs of cars with these trucks which have been supplied to various roads in the country.

An appropriation of $30,000 has been made by the Pennsylvania Railroad Company for a Young Men's Christian Association building at Wall, Pa.

It is reported that American railway corporations contribute $130,000 annually to the work of local Railroad Young Men's Christian Associations along their lines. Forty-six buildings, whose value is $560,000, are owned or held by the Railroad Associations for this use.

MASTER CAR BUILDERS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Thirtieth Annual Convention.

(*Continued from page 164.*)

Passenger Car Ends and Platforms.

Committee: E. W. GRIEVES, C. A. SCHROYER, T. A. BISSELL, F. D. ADAMS, M. M. MARTIN, J. J. HENNESSEY, S. PORCHER.

Your committee submits to the Association a drawing of a construction that it considers a combination of the best practices now in use, with some additional improvements in same, for your consideration; but your committee, after careful investigation, has every reason to believe that this construction infringes patents now in use; therefore, it is not in position to recommend that it be adopted as a recommended practice of this Association.

The drawing shows the side sills reinforced ½ by 7-inch iron plates placed between the side sill and a 2-inch sub sill, and the same thickness of plate placed between the center sill and the 2½-inch sub sill, each extending back to the tie timber and bolted together in the same manner. The end sill is made 8 by 8 inches, with ¾ by 3½ by 7-inch angle iron placed between the wood and bolted together.

The corners at end and side sills are secured together with ¾ by 7-inch wrought-iron corner bands and ¾-inch bolts. The center sill plate is flanged against end sill and secured in same manner. The end wall framing is reinforced by ½ by 2 by 3¼-inch angle irons, which are flanged to end sill and end plate, and part of the angle iron extending down, connecting the angle irons on the posts to the same on end sill and end plate, making a continuous iron frame on end of car. The vertical tie rods are used in the usual manner to secure the end plate to end sill.

The committee would call attention to the fact that this construction makes a solid iron frame for one end of car, each piece being secured to the other, forming one continuous iron frame. The platform and arrangement of buffer plates, springs, etc., are familiar constructions and are a combination of different platforms now in use, the main feature being that the retaining springs are for the purpose of keeping the buffer and springs in position when not in contact with another car, and the use of the combination malleable iron crosshead guide and buffer spring casting, which abuts against the end sill. Another feature of this platform is the arrangement of draft springs, and the use of cast steel follower carry iron and double pockets, which, in connection with the followers, tail pins and spring pockets, allows the use of two draft springs, thus doubling the capacity of springs without increasing the deflection. The coupler stirrup is also somewhat improved in that it has a very large opening for coupler, which allows sufficient movement to overcome any transverse strains on the platform timbers, the coupler being held in alignment by side springs. The coupler stirrups have enlarged ends and are secured to end sill with two 1-inch rods. The draft timbers and platform timbers are plated with ½-inch iron, which extends the full length of timbers.

The impact required to make a coupling between two cars is exerted only on a small center and two side buffer springs which are calculated to have a capacity of 13,700 pounds, while any other compression after the cars are coupled will go to the buffer springs, having a total capacity of 25,700 pounds. Any compression, when the cars are coupled, would also go on the draft springs through the coupler, and the draft springs would have a capacity of 32,400 pounds, and this, combined with the buffer springs, gives the total buffing spring capacity of 58,100 pounds. The working load of this spring, however, is only about one-half of these figures, or 29,050 pounds. The push-bar is attached to the coupler at the tail pin connecting with cross-head at back of center buffing springs, thus transmitting the draft strains to the buffer springs, keeping the buffers always in contact when cars are coupled together.

Location of Air-Brake Cylinders on Freight Cars.

JAS. MACBETH, ROBT. GUNN, H. C. MCCARTY, B. HASKELL, F. B. GRIFFITH, A. C. ROBSON, JOEL WEST, Committee.

Your committee finds, on the basis of 1,210,000 freight cars in service at the present time, which is taken from recent reports of the Interstate Commerce Commission, that approximately one-third of this number are now equipped with air-brakes. Experience has demonstrated, at various inspection points, that 55 per cent. of the freight equipment interchanged is equipped with air-brakes at the present time, owing to the fact that a large percentage of cars not equipped with air-brakes do not leave the line of some companies owning the same. This clearly emphasizes the volume of work for the proper maintenance of the brake, and also the additional duties to the inspecting and repairing force. It is therefore apparent that the air-brake cylinders and triple valves should be located in such a position that the attention they require can be readily and safely given, causing the least possible delay to traffic, and result in maintaining the brakes in the most efficient manner. The committee would therefore make the following recommendations:

Air-brake cylinders and reservoirs should be placed on cars on a line inside of stake pocket as near center of car as possible. A clearance of at least 12 inches should be allowed for the removal of cylinder head. Special attention is called to this point, as a number of railroads are now locating cylinder in a position which brings cylinder head within four or five inches from needle beams or other parts of car, preventing, without great difficulty, the removal of head.

The main pipe should be located as near the outside line of side sill as possible. This will enable the men to readily reach and clean the drain cups in main air pipe, and will also place the pipe in a position on gondola cars, where the least possible injury will be caused by the dripping of water on pipe after having passed through bituminous coal that cars may be loaded with.

The cut-out cock should be located under the car near the center, where it can be reached from either side, and be subject to the least interference by irresponsible parties, which already has developed.

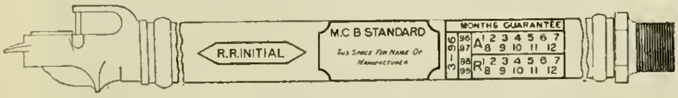
The air brake branch pipe should be connected to top of drain cup in main pipe instead of bottom, in order to avoid, as far as possible, the tendency of dust and dirt to pass through strainer to triple valve.

The release valve should be placed on top of reservoir and handle extended to each side of car.

When necessary to provide holes in needle beam or other parts of car to accommodate rods or levers, the committee recommends that they be made sufficiently large to allow ample space for the operation of rods or levers, as it has already been found that openings provided have been so small as to prevent rods from moving.

Rods should be parallel with line of car, as far as practicable, and properly supported with hangers, to avoid binding and breaking of piston sleeves.

The committee received, after its appointment, a communication from the secretary, stating that it was the desire of the president that it also take up the question of, and incorporate in its report, a method of marking hose, so that the lifetime and service of hose could be more carefully and intelligently followed up.



Proposed Marking of Air Brake Hose.

It is known that some of the leading manufacturers are now marking the hose they maoufacture. Their plans were considered, together with additional points that the committee considered essential, in order that the highest uniform degree of efficiency may be reached in hose, and would therefore recommend the marking as shown on accompanying cut.

The number of months' guarantee was omitted, as in the opinion of the committee this is a question between the railroad purchasing and the manufacturer, and by requiring that all hose be plainly marked with the initial of the road purchasing and manufacturer's trade-mark or name, and also a time guarantee, the character and service of the hose can be readily followed up, and such hose, with a very limited time guarantee, will soon develop to the purchaser and manufacturer its inferiority or superiority compared with other hose.

Size of letters and figures to be not less than one-quarter of an inch.

Stenciling of Cars.

A. M. Waitt, S. Higgins, H. S. Hayward, Committee.

Your committee, to whom was referred the communication from the Car Inspectors' Association of North America, recommending for the facilitating of work of inspection that all car owners be requested to stencil height and width of all high cars on the side of the car, and also that car owners be required to stencil size of journal on truck planks; also the numbers and initials of all box cars on floor timbers between cross-tie timbers, begs to report as follows:

Communication with the Secretary of the Car Inspectors' Association develops that the reasons for requesting the adoption of their recommendations are:

First. To expedite the movement of freight, especially at night, when it is difficult to read the car numbers and initials where they are located high up on car side.

Second. To save loss of time in having to measure unusually large cars in order to know whether they will properly clear bridges, tunnels, etc., on the receiving company's lines.

Third. To facilitate movements of inspectors in ascertaining proper size of journal bearings or axles in connection with repairs.

Your committee wishes to commend the spirit of interest in the improvement of the service shown by the action of the Car Inspectors' Association, and we believe the suggestions made are good ones and worthy of having the general approval of the M. C. B. Association.

There are some difficulties in the way of carrying ont literally the proposed stenciling on account of the different contour lines of high cars, and from the fact that some special classes of cars are sheathed over underneath, covering in the sills and floor timbers.

We believe, on the other hand, that the recommendations of the Car Inspectors' Association do not go quite far enough in attaining the desired smoothness in handling inspection work at interchange points. Oftentimes it is impossible for inspectors to tell, in connection with some of the prominent and expensive features of the cars, what is the proper standard. It would seem, to your committee, desirable to a limited extent to cover these points by proper stenciling. Your committee would, therefore, recommend:

First. That on all box cars standing more than twelve (12) feet from top of rail to eaves, the width at eaves be stenciled in 3-inch letters on side of car, as near the bottom as convenient.

Second. That all box, stock and other roofed cars have the number and initials stenciled in 3-inch letters on outer face of outer floor timber between cross-tie timbers, except where cars are ceiled over underneath, in which case the stenciling shall be put on inside face of each cross-tie timber in center.

Third. That all classes of cars have style of coupler and rear attachments, and style of brake-beams stenciled in not less than 1½-inch letters near one end of car on each side, or on each end of car directly above the buffer blocks where design of car permits it.

Fourth. That where the construction of the truck permits trucks shall be stenciled on each side, giving the size of journal, and the letters "M. C. B." if the axle is M. C. B. standard axle. If the axle is not M. C. B. standard use dimensions from center to center of journal in place of M. C. B. This stenciling to be in 1¼-inch letters and to be put on end or side of bolster in Diamond trucks, and on side-truck frame in center on Fox trucks.

Fifth. That on all cars equipped with air-brakes the words "Air Brake," in letters not less than 3 inches high, be stenciled on the sides or ends of the cars, and that the make of air-brake equipment be stenciled (in smaller lettors if desired) over or just preceding these words, to enable inspectors to detect repairs made with wrong material. Respectfully submitted,

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Twenty-Ninth Annual Convention.

(*Continued from page 157.*)

Reciprocating Parts.

Committee, H. D. Gordon, C. F. Thomas, C. G. Turner, T. A. Lawes, J. A. Hill.

The committee making this report assumes that the necessity for keeping down the weight of reciprocating parts is appreciated, and it proceeds at once to discuss various designs for such parts. Under the head of pistons a number of designs are illustrated as follows: London & North Western Railway, single plate cast steel piston, 30 inches diameter, weight 288 pounds; an 18 inch piston, weight 139 pounds; Richmond Locomotive Works, single plate steel piston, 31 inches diameter, weighing 387½ pounds, and complete with rod 535 pounds; a similar 20-inch piston complete with rod 358 pounds; Pennsylvania R. R. single plate steel pistons, one 20 inches diameter, weighing 221 pounds, and one 29 inches diameter, weighing 395 pounds; a steel box piston with eastiron bull-ring, built by the Schenectady Locomotive Works, of which one 19 inches in diameter complete with rod, weighs 318 pounds; also a Schenectady single plate cast steel piston of the same size weighing complete with rod, 299 pounds; and the malleable iron piston of the Norfolk & Western Railroad, illustrated in our June issue. In the way of piston rods the report illustrates a hollow rod, 3½ inches, outside diameter, with a 1¾-inch hole through it from the front end back to the crosshead fit, which design one member of the association intends to try. Various types of crossheads are illustrated, for four-bar, Laird, and other two-bar guides, some of them reduced to the smallest possible weight consistent with strength. The detailed weight for reciprocating parts for standard engines on the London & Northwestern Railroad, the Northeastern Railway of England, Lancashire & Yorkshire, and Caledonian Railway of Scotland, conclude the report.

Steam-Pipe Joints.

George Gibbs, E. A. Williams, John Hickey, J. J. Ellis, John Smith, Committee.

As far as the committee has been able to learn it appears to be the uniform modern practice to use cast iron for both steam and exhaust pipes, and this practice appears to give satisfactory results.

Two roads report having made experiments lately with wrought and malleable iron for steam-pipe material. The results are said to be satisfactory, except in the matter of first cost. These pipes are made as thin as consistent with strength and it is claimed they spring so readily that strains on joint-bolts are much relieved and frequency of leaky joints thus lessened.

All but one member state that some form of brass rings are used for top and bottom steam-pipe joints. These rings are sometimes double convex, in others concavo-convex, but most generally plano-convex.

Two members have tried cast-iron joint rings, but condemn them on account of corrosion and the brittleness of the metal, which makes them more difficult to handle. Another member, however, representing a large railway system, prefers cast-iron rings; states they give less trouble than brass, which latter he is replacing as rapidly as possible.

For exhaust-pipe joints, the general custom is to make them with flat surfaces, cast iron to cast iron, scraped to a fit.

Steam-pipe joints are usually secured by two bolts or studs top and bottom, which pass through cast flanges on the pipes, tee-head and saddle. Many of the members who replied to the committee consider this form of joint satisfactory. But others, the majority of whom are using heavy engines in severe service and with high steam pressures, report increasing trouble with loose joints. Their opinion seems to be that more bolts should be used, preferably four top and bottom. The few results obtainable with these reinforced joints seem to indicate that it is the proper solution of the difficulty.

In summing up the information furnished by members, your committee can find little well-grounded complaint with present form of pipe joints in locomotive front ends. And practice is so uniform, even as to details, as to indicate a substantial accord throughout the country in ideas of a satisfactory arrangement. It is quite easy to get the impression, from the ordinary attention to roundhouses which a master mechanic is able to give, that regrinding joints constitutes the chief item of roundhouse repairs, while in reality such work may not be more than would ordinarily be expected from results of service wear aud tear.

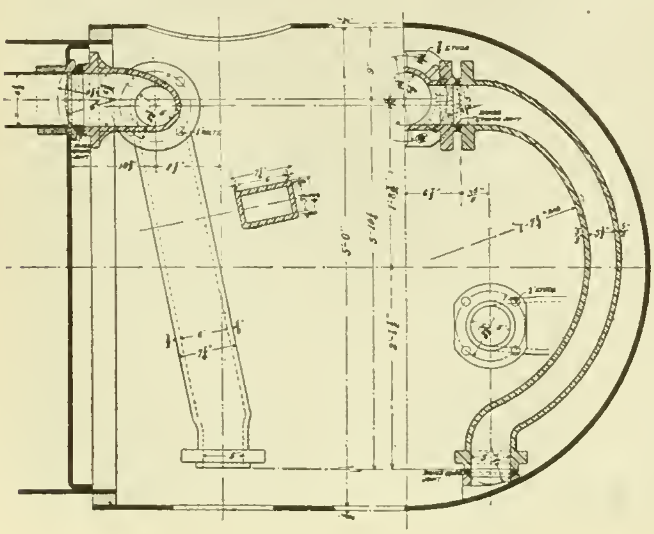
Exhibit of Root's Improved Steam Boiler at the National Electrical Exposition.

It is true that repairing joints is an annoying and lengthy operation with the modern extension front locomotive, laying up the engine for about three days' time, and taking up valuable roundhouse room. The cost of regrinding steam-pipe joints on both ends, at a large division point, may be taken as follows:

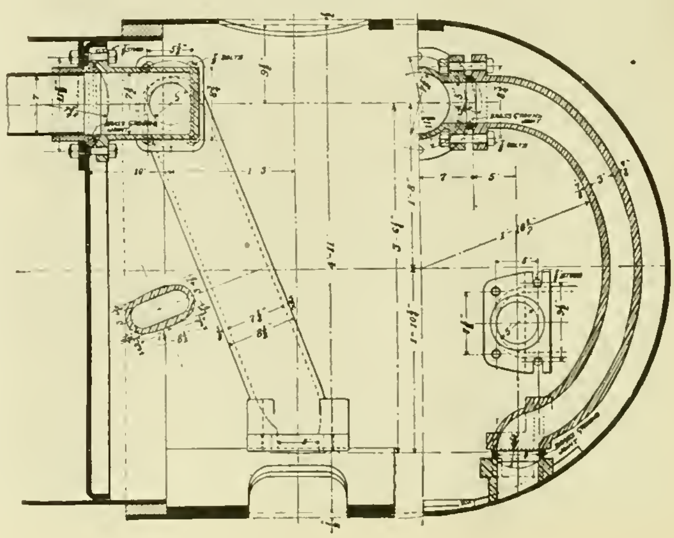
Removing and replacing front end	4 hours
" " " steam pipes	6 hours
" " " netting	4 hours
" " " plates	3 hours
Grinding joints	10 hours

On all above operations two men are employed, making 54 hours of labor. At rates usually paid machinists, boilermakers and helpers, the total cost of the operation is about $10.

In this same large roundhouse, in which 150 engines are turned per day, it was found that between three and four engines per month have pipes reground. Of these, about 40 per cent. had either loose cylinder saddles or had been out of shops after general repairs from two to three months only. In this latter case, the defect was probably caused by some imperfect shop work; and in the former, joints could not be expected to remain tight; in fact, the testimony



Locomotive Steam Pipes.—Fig. 1.



Locomotive Steam Pipes.—Fig. 2.

of members leads to the conclusion that trouble with joints is quite infrequent except on account of bad workmanship, loose saddles or insecure bolting in high-pressure heavily worked engines.

The suggestions for improvement made by members follow from the above, and are, briefly, that saddle fastenings be kept tight, and that more bolts be used to hold the pipe flanges together beyond a possibility of their working under the strains caused by expansion.

Your committee would, therefore, offer conclusions in line with the above given evidence, and make the following recommendations for approved practice:

Steam pipes should be of cast iron of flattened section, as light in the body as consistent with strength and the requirements of foundry practice. The shape of the pipes and general arrangement of the joints should be as shown in Figs. 1 and 2.

Your committee suggest, as worthy of trial, pipes of malleable iron or cast steel. Such pipes may be quite thin and still have ample strength, with the resulting advantage of springing instead of working at the joints when expansion strains are brought upon them.

The flanges should be arranged, where possible, to take four bolts or studs at both ends on all heavy engines. These bolts should be equally spaced, if possible. The joints should, in all cases, be made up with plano-convex brass joint-rings, the radii of their convex faces to be about equal to the inside diameters of the rings. These rings should be carefully ground upon their corresponding joint surfaces.

The exhaust-pipe joints should be made with flat surfaces, carefully scraped and fitted with surface plate, and bolted together without copper or other gaskets. A small amount of red lead, or some kind of heat-hardening cement, may be used if preferred.

Figs. 1 and 2 are submitted as representing good practice in the make-up of heavy joints.

Exhibit of the Root Improved Steam Boiler at the National Electrical Exposition.

Our illustration gives a very good view of the exhibit made by Messrs. Abendroth & Root Manufacturing Company, 28 Cliff street, New York, of their well-known improved Root water tube boiler at the recent National Electrical Exposition, New York City.

These boilers were selected by a special committee to furnish all the steam used at the Exposition, the desire being to install a thoroughly reliable and model up-to-date boiler plant.

This was the only working boiler plant shown and attracted much attention and favorable comment from visitors, who could not but be impressed with its cleanliness, efficiency and the ease with which it was managed. There were two equal units, forming one battery of 500 horse-power. A Wilkinson automatic stoker was used to distribute the coal upon the fire.

The evaporative efficiency ranged from 10 to 11 pounds of water to a pound of coal. The C. W. Hunt noiseless conveyor was used in delivering the coal and taking away the ashes.

So safe and simple was the entire operation of this plant that it was put in charge of Mrs. Frank Walton, a licensed woman engineer, who, as chief engineer, managed the exhibit with skill and judgment.

The battery of improved Root boilers used at the National Electrical Exposition was an exact duplicate of the six batteries of Root boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

Henry F. Hill, 123 Oliver street, Boston, Mass., has been appointed New England agent for the Ingersoll Milling Machine Company.

The Cincinnati, Hamilton & Dayton road is making preparations at its Lima shops for the equipment of all its cars with automatic car couplers.

The Nordberg Manufacturing Company, of Milwaukee, manufacturers of engines, are increasing the capacity of their works, the Niles Tool Company, of Hamilton, O., supplying the new machinery.

Since the Saratoga conventions the Sams coupler has been ordered by seven Eastern railroads, and is being put into service by many companies on special equipment cars and on cars that do not go into interchange traffic.

The contract for the building of the Butler & Pittsburgh Railroad was let last month. There were 47 different bids representing 100 firms all over the country. The contract was given to C. I. McDonald & Company, of Pittsburgh.

The Sargent Company, of Chicago, have made a contract to handle the "Compo" brake shoe in the West. This shoe is a composition of cast-steel and compressed wood, and is meeting with great favor on electric and elevated railroads.

Mr. Otto Goetze, 114 Broad street, New York, has issued a little pamphlet descriptive of "Mannocitin," and containing the opinions of some leading American firms regarding it. Mannocitin is a rust-preventive which those who have given it a trial find to be most excellent. Any one wishing to obtain a copy of the pamphlet can do so by applying to Mr. Goetze.

The Q & C Company, Chicago, has recently made a valuable addition to its Perfection Oil Purifier, illustrated in our April number. This is a thermostatic temperature regulator, which automatically holds the temperature at a degree which facilitates the filtration of the oil without overheating. Several of these are in operation with very satisfactory results.

The firm of Wilson & McIlwain, manufacturers' agents, at Pittsburgh, has been dissolved by the withdrawal of John T. Wilson, whose other business interests made it impossible to devote the necessary time to the firm's affairs. Mr. McIlwain has associated with him his son, Harry M., and will continue the business under the firm name of J. D. McIlwain & Company.

The Brown Hoisting & Conveying Machine Company, Cleveland, O., have sold to E. D. Smith & Company two standard 10-ton locomotive cranes to be used on the work of extending the wheel pits of the Niagara Falls Power Company, to accommodate seven more 5,000 horse-power turbines. These cranes are fitted with extra large drums to take the great length of rope that will be required in hoisting out of the wheel pits.

To the New York Steam Company's Cortlandt street plant has recently been added a 1,000 horse-power boiler weighing 119,000 pounds, or 59½ tons. The boiler was built by the Edgar Boiler Company, Limited, of Warren, Pa. It is of the vertical tubular cylindrical type, 23 feet long and 10 feet in diameter, with 220 tubes 5 inches in diameter. The shell is of ¾-inch steel. A 7-inch circulating tube surrounds each tube from the water line to near the bottom head.

The Ingersoll-Sergeant Drill Company have received an order from the Pennsylvania lines for four half-duplex air-compressors of the class "G" pattern, with Myer valve gear. The steam cylinders are 10 inches in diameter; air-cylinders 10¼ inches in diameter; stroke 12 inches. These compressors will be located as follows: One at Columbus, O.; one at Denison, O.; one at Indianapolis, Ind., and one on the Vandalia road at Terre Haute. The Big Four has also ordered a similar compressor for its Brightwood shops.

During the month of June Mr. Henry L. Leach, 176 Huron avenue, North Cambridge, Mass., shipped 170 sets of his pneumatic sanding apparatus, 119 of these going to the various locomotive builders for new equipment, as follows: To Baldwins, 25 for Lehigh Valley; to Pittsburgh, 22 for Vandalia and 12 for Seaboard Air Line; to Schenectady, 5 for Southern Pacific, 10 for New York, New Haven & Hartford and 2 for Fitchburg; to Cookes, 5 for Southern Pacific and 10 for Baltimore & Ohio; to Richmond, 25 for Baltimore & Ohio; to Brooks, 3 for Burlington, Cedar Rapids & Northern. Among the shipments for old equipment were 30 for the Norfolk & Western and 12 for Southern Railway.

The Carnegie Steel Company, Limited, nearly two years ago, after making an investigation of the merits of the Cahall vertical water tube boiler, put in a trial plant of these boilers of 2,000 horse power at their gas pumping plant, at Bagdad, Pa. The performance of the boilers was such a marked improvement over the general boiler practice of to-day that four of these boilers were afterward put in at their Edgar Thomson Steel Works. They have been so well satisfied with the work done by these that they have made arrangements to tear out all the old style boilers at furnaces A, B and C at the Edgar Thomson Steel Works and have purchased 5,250 horse power of the Cahall vertical water tube boilers, to be installed in place of the ones to be removed.

The facilities of the Roberts Safety Water Tube Boiler Company have been so greatly enlarged that they have just completed a 150 horse-power Roberts boiler for the steam yacht Sultana, on an order from the Erie Basin Dry Dock Company, in eight working days from the time they received the order. This boiler is built in the company's best style, the material has all been inspected, and the boiler will pass inspection for 250 pounds of steam. Two weeks' time was allowed by the contract, but the owner was very anxious to have his yacht in commission on July 4th, and the Roberts Boiler Company decided that they would beat the record on boiler building, and have undoubtedly done so. Notwithstanding the lateness of the season, they are running full time and have been working nights and Sundays lately.

The contract for the new bridge, to take the place of the railroad suspension bridge now spanning the Niagara River, has been awarded to the Pennsylvania Steel Company, Steelton, Pa. The new bridge will have a span of 550 feet between piers, with short spans connecting the main span to the bluffs. It will have two floors, the upper one for two railroad tracks and the lower one for carriages, trolley cars and pedestrians. The piers will be of masonry built on the limestone about half-way up the sides of the bluff. The superstructure will require 2,780 tons of steel plates and angles, 109 tons of steel castings, 91 tons of steel I-beams and pins, and 15 tons of iron rods and turnbuckles. The bridge is designed for a load on the railroad floor of two consolidation engines, with 40.000 pounds on each pair of drivers, followed by a train of 3,500 pound per lineal foot, and at the same time the highway floor is to suppors a live load of 3,000 pounds per foot

The Bates Thermic Engine Company, of Philadelphia, has been organized to build engines for furnishing power through the medium of gas. Russell Thayer is President of company, and Allan B. Rorke John F. Betz, Prof. W. D. Marks, Professor Houston, Professor Kennelly, Clement Newbold, D. S. P. Chew, Dr. Filbert. E. C. Quinn, Henry Clay, Jas. McManes, Jas. H. Harper, Clarence L. Harper and others are prominently connected with it. The engine to be built will produce power direct from fuel. It will require from 35 to 40 per cent. less space than ordinary engines, and save 25 per cent. in weight per effective horse power, which in steamers and torpedo boats is an immense advantage. The makers will gurantee a saving of 60 per cent. in the fuel necessitated by the use of the modern engine. Three of these engines are at present in operation in Europe, and five others are in course of construction. The fuel is burned under pressure in a small chamber near the engine cylinder and the gases of combustion used expansively in the cylinder.

The Hazelton Boiler Company, New York City, reports recent sales of boilers, aggregating 2,450 horse power, as follows: The Rochester Gas & Electric Company, Rochester, N. Y., 500 horse power; the Lambertville Rubber Company, Lambertville, N. J., 200 horse power; the Goodyear Rubber Company, Middletown, Conn., 150 horse power; the Bristol Electric Light & Railway Company, Bristol, Conn., 200 horse power; the Equitable Gas Light Company, New York, 500 horse power; the Pettebone-Cataract Paper Company, Niagara Falls, N. Y., 250 horse power; the North Adams Gas Light Company, North Adams, Mass., 150 horse power; the Canandaigua Electric Light & R. R. Company, Canandaigua, N. Y., 250 horse power, and the Newton Falls Paper Company, Newton Falls, N. Y., 250 horse power. They have also recently completed contracts with the Capewell Horse Nail Company, Hartford, Conn., and Messrs P. & F. Corbin, New Britain, Conn. The company reports that nearly all of their orders now being received are for the very earliest possible delivery, and that many of their recent sales have been made to old customers who are now enlarging their plants. The original boilers sold to these customers have been in constant operation for from eight to ten years, without repairs, still carrying high pressure, and giving the same fine results as when new. This, together with the fact that the Hazelton Company has made various improvements in the construction and setting of their boilers, increasing their efficiency and economy, and improving their appearance, makes it much easier for them to make sales now than formerly.

The Edward P. Allis Company, of Milwaukee, Wis., are at present very busy. Among the recent orders they have received may be mentioned two cross compound engines of 1,000 horse power each, direct-coupled to electric generators, for the Syracuse Street Railway Company, Syracuse, N. Y.; one engine of 800 horse power for the Brockton Street Railway, Brockton, Mass.; large hoist for Butte, Mont.; four large engines for the Otis Falls Pulp Company, Maine; a cross compound condensing engine for the McCormick Harvester Machine Company, Chicago, and a tandem compound engine for the Sandusky Electric Light Company, Sandusky, O. Their engine department has in hand the order recently received from the Northwestern Elevated Railway Company, of Chicago, for 9,000 horse power of engines, and they have just shipped a vertical compound condensing engine of 2,500 nominal horse power to the Warren Manufacturing Company, Warren, R. I. They have just started a twin tandem compound condensing engine of 2,500 horse power in the new Berkshire Cotton Manufacturing Company mill, Adams, Mass., and the first of the six large pumping engines which they are building for the city of Pittsburgh, in addition to which they have shipped the Canal & Claiborne Street Railway Company, New Orleans, two tandem compound condensing direct-coupled engines of 700 horse power each.

Their mining department has just received an order for the complete machinery of a large new reduction works to be built in Colorado. This order includes the engine, boilers, crushers, rolls, concentrators, chlorination barrels, etc., etc., in fact the entire machinery of the plant. The company's saw-mill department has had an order placed with them for the complete machinery of a mill in California which will be one of the largest saw-mills in the country. They supply in addition to the saw mill machinery the necessary engines and boilers. There are now in operation six of the twelve vertical compound condensing blowing engines which the concern is building for the Carnegie Steel Company, and these machines in service more than exceed the expectations of all concerned. They are also about to ship a pumping engine to the city of Sacramento, Cal., and are beginning work on the large pumping engine recently ordered for Cleveland.

Our Directory

OF OFFICIAL CHANGES IN JULY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Altamont & Manchester.—President C. C. Crooke died July 9.

Kansas City, Oklahoma & Southwestern.—Mr. K. H. Bates has been elected President.

Louisville, New Albany & Chicago.—Mr. B. E. Taylor has been appointed Purchasing Agent, vice J. H. Craig, resigned.

Buffalo, Attica & Arcade.—Mr. S. T. Dyke is acting Master Mechanic in charge of rolling stock and road bed.

Brainerd & Northern.—Mr. O. O. Winter is appointed General Manager.

Boston Terminal.—Mr. J. C. Sanborn has been elected General Manager.

Atlantic & Pacific.—Office of General Manager and Receiver removed to Great Northern Building, Chicago. W. H. Smith is appointed Purchasing Agent, with office at Albuquerque, N. Mex.

Rutland.—Mr. Geo. W. Kenney is appointed Superintendent of Motive Power, with office at Rutland, Vt.

Seaboard Air Line Belt.—Mr. R. C. Hoffman is chosen President to succeed Mr. J. H. Winder, resigned.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. A. G. Wright has been appointed Division Master Mechanic at Altoona, Wis., to succeed Mr. W. E. Amann, resigned. Mr. H. G. Burt succeeds Mr. E. W. Winter as General Manager.

Wabash.—Mr. Sidney Emerson has been appointed Chief Engineer, with office at St. Louis.

Texas, Sabine Valley & Northwestern.—Receiver L. Hars has resigned.

Georgia Northern.—Mr. A. McLean has been appointed Superintendent of Motive Power, with office at Pidcock, Ga.

Pittsburgh & Lake Erie.—Mr. J. T. Atwood has been appointed Chief Engineer.

Missouri, Kansas & Texas.—Mr. S. B. Fisher has been promoted to be Chief Engineer, with office at St. Louis.

Eagles Mere Railroad.—Joel H. DeVictor has been elected Vice-President, with office at Philadelphia, Pa., vice John R. T. Ryan.

Peoria, Decatur & Evansville Railway.—H. W. Matters having resigned, W. J. Lewis has been appointed Purchasing Agent, with headquarter at Evansville, Ind.

Lehigh & Lackawanna Railroad.—L. A. Riley has been elected President.

Cleveland, Akron & Columbus Railway.—T. H. Perry is Purchasing Agent, with office at Indianapolis, Ind.

California Eastern.—The following is a list of the officers of the new company: President, R. W. Woodbury; Vice-Presidents, D. G. Scofield and W. N. Byers: Treasurer, I. B. Newton, and Secretary, R. S. Seibert.

St. Louis, Avoyelles & Southwestern Railway.—Hugh J. Fitch has been appointed Receiver of this company.

Columbus, Sandusky & Hocking.—Mr. N. Monsarret has resigned the positions of President and General Manager.

Denver, Lakewood & Golden Railroad.—W. F. R. Mills has been appointed General Superintendent and Purchasing Agent, vice J. B. McCormic, previously General Superintendent.

Marshfield & Southeastern Railway.—Charles H. Grundy has been appointed General Manager, with office at Marshfield, Wis., vice A. A. Hopkins. The Chicago offices are removed to. Nos. 508-9 Roanoke Building.

Southern.—Mr. Josepe H. Green, Master Mechanic at Columbia, S. C., has resigned.

South Carolina & Georgia.—Mr. Joseph H. Green has been appointed Superintendent of Motive Power, with office at Charleston, S. C.

Marietta & North Georgia.—Mr. Joseph McWilliams has been appointed General Manager.

St. Louis & San Francisco.—Mr. B. F. Yoakum is General Manager, vice Mr. H. L. Morrill, resigned.

Fremont, Elkhorn & Missouri Valley.—Mr. George F. Bidwell has been made General Manager, vice H. G. Burt, resigned.

Suffolk & Carolina.—General Manager J. H. Macleary has resigned and Superintendent George L. Barton will perform the duties of the office until further notice.

Employment.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

III.

(*Continued from page* 169.)

The focus of Altoona is the Logan House, a hotel which was built soon after the shops were located there, and which is now in the center of the city on the north side of the railroad tracks, the great locomotive repair shops being on the south side and opposite to the hotel. The hotel is not shown in the plan of the shops, which was published in our June number.

For convenience of reference this plan is reprinted herewith, and the position of the hotel is indicated in the reprint. The erecting shop, No. 1, shown in the plan, is directly opposite to the hotel and first attracts attention. It was, we believe, the first shop of the kind in this country which was built with longitudinal tracks and overhead traveling cranes, and has been the subject of frequent study and much criticism by railroad men ever since it has been erected. The cranes were made in England and are carried in brick arches along the sides of the shop. These are large and cumbrous and exclude a good deal of light, and would not be repeated if the shops had to be rebuilt. In fact it is said that the cranes which were originally put into this shop are now too light for the heavy engines which must be handled, and plans are under consideration to replace the cranes with heavier ones, and substitute an iron supporting structure to carry them.

Erecting shop No. 2 forms a part of the same group of buildings and is similar to No. 1, and has three longitudinal tracks with a pair of overhead travelling cranes which were built in Altoona. They, too, are carried on brick arches, but these are arranged so as to light the shop better than No. 1 is lighted. The two side tracks each have a pit, while the centre one has not. The engines to be repaired are placed on the side tracks, and the middle one, as far as possible is kept clear. The space between the middle and side tracks is excavated and covered over. In these basements, as they may be called, the water and steam pipes for heating the building and testing boilers are located, In the No. 1 shop the pump and accumulator for the water pressure, are located under the floor. The boilers are all tested first by a cold water hydraulic test, and then with hot water and steam pressure. For both tests the water is conducted to the boilers by the system of pipes described, and in making the steam test the boilers are entirely filled with water, which is then heated, and expanded with steam from the steam pipes.

The space below the floor is also used for storing the parts of engines, which are brought in for repairs, and are dismantled. The woolen floor is removable which enables the parts to be easily deposited in the basements and taken out again when they are needed.

There is room for nine engines on each track and about 34 can be repaired and turned out each month in each shop, although the average is not as great as that number. The cranes are not very rapid in their movements and for that reason they are used for handling only the heaviest parts of the locomotives which are being repaired. As has often been explained, any engine can be lifted up bodily and transferred laterally over the middle track, and then moved longitudinally to any point in the shop, and again carried over to either side track and placed wherever it may be required. In this way, if for any reason it is desirable to give precedence to some engine, it can be taken up and placed in any desired position,

These shops and the appliances in them have now been in use for a good many years and although the relative merits of shops with longitudinal and transverse tracks is still a much-disputed question it would be hard to find any one about Altoona who would advocate the building of an erecting shop with transverse tracks and a transfer table, which is the usual plan adopted in this country.

The general arrangement of these shops may be commented on. The machine shop is a two-story building centrally located between the two erecting shops, with which it is connected by wings at the south end. At the north each of the three parallel shops abuts against a transverse building with tracks leading out to a transfer table. In this shop the cylinders, frames, trucks, etc., are assembled, and put together, preliminary to being taken into the erecting shops. Between the machine and erecting shops there are open spaces where wheels, castings, etc., are stored temporarily before being taken into the shop. West of the transfer-table is the wheel shop, smithy and boiler shops. The wheel shop is in a direct line with the machine shop, and all the buildings last referred to are connected with the transfer table and by that means material or partly finished work can be carried to any part of the machine or erecting shops. Still farther north is the wheel foundry and another larger foundry for general castings. The brass foundry and other smaller buildings are distributed as shown in the plan from which it will be seen that what may be called the co-relation of the shops is very convenient and that although the present arrangement of buildings has been the result of a process of evolution it has not been without a system which has evidently been carefully thought out. The location of the three round houses Nos. 1, 2 and 3 is shown and also that of the testing laboratory which is now famous the world over.

At the time of our visit to the erecting shops all the engines in No. 1 it was noticed had Belpair boilers. The Pennsylvania Railroad has adopted this form of boiler more extensively than any other line in this country, and, apparently, have no present intention of abandoning it, but are applying it to all new engines which are built and to old ones which are rebuilt. It is true that some of the earlier boilers of this type, which were too small, have been removed and are now used in stationary service, but the number is constantly being increased and the type is adhered to, which indicates that it has been giving satisfaction. Some

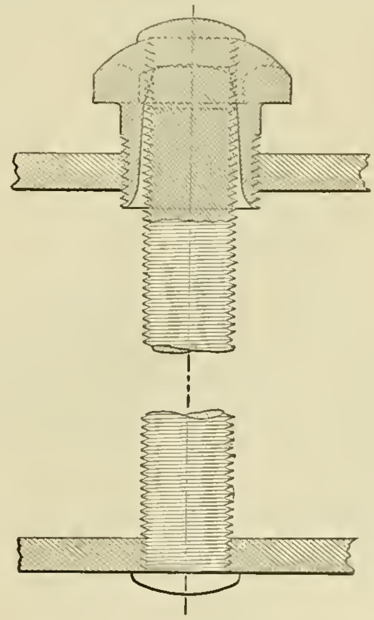
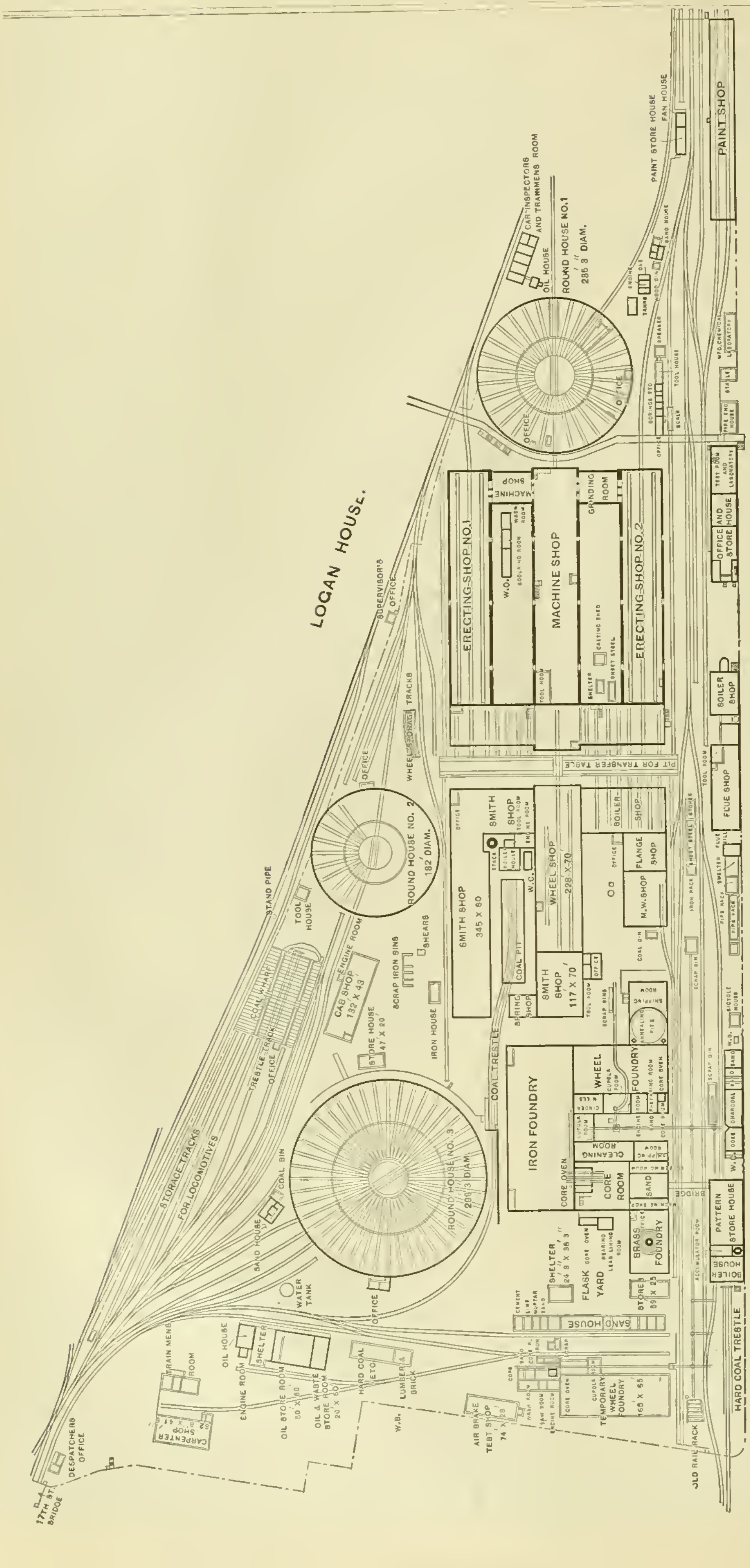


Fig. 1.—Flexible Staybolt.

trouble has been experienced with them in common with all other locomotive boilers from the breaking of stay-bolts. It was observed that more stay-bolts break in steel than in iron plates, and that the tighter the bolts are screwed into the plates the larger the number of breakages were. From this and other facts the inference was drawn that the rigidity of the bolts had much



PLAN OF LOCOMOTIVE REPAIR SHOPS, ALTOONA, PA.

to do with their failure. Mr. Joseph Nixon, the foreman of the boiler shops, was therefore led to design the form of attachment shown in Fig. 1, which permits of some degree of flexibility in the bolt, and also provides a more secure fastening. It consists of a nut with a tapered thread $1\frac{3}{8}$ inches in diameter which is screwed into the outside plate of the fire box. The hole on the inside of the nut is tapered, and "runs off to nothing" in the thread, which is cut in the outer end of the hole. The point of flexure of the bolt is thus distributed over some distance and is not concentrated at one point. The bolt is riveted over the outside of the nut, as is usual, and the inside end is screwed and riveted into the fire-box plate in the usual way. The nuts were first made of brass, but are now made of malleable iron. They were first applied to boilers in 1892, and they worked so satisfactorily that they have gradually been used more and more, and now orders have been given to apply them to all boilers which go through the shops. Thus far no bolts have been found broken which are fastened in this way. They are put in the upper rows which are most liable to break, and in some engines in all places where the nuts will not interfere with the attachments to the boilers. The drilling of the ends of stay bolts it has been found will not always reveal a fracture if it occurs, and it was partly for that reason and also to lessen the cost of repairs that this method of fastening bolts was designed by Mr. Nixon and adopted by the company.

A good many years ago the Pennsylvania Railroad had in its equipment a number of Winans Camel engines which some of our older readers will remember had fireboxes, the crown sheets and tops of which sloped downward and backward from the barrel of the boiler, and were stayed with ordinary stay-bolts. Later the Pennsylvania Railroad Company built some consolidation engines with similar fireboxes which have been known as Class I engines. It is said of the boilers of these engines that they are the cheapest to maintain of any on the road, as they are also the lightest boiler in proportion to their size of any in use. Having some interest in this we made inquiry and ascertained the weights of three classes of boilers: 1st, Class I, of the kind described; 2d, Class A, for anthracite coal, but having a wagon top and crown-bars, and Class R, a Belpaire boiler. The following table gives the weights of the boilers as they leave the boiler shops without flues, their heating surface and the weight per square foot of heating surface:

Class.	Weight of boiler.	Heating surface.	Weight per square foot of heating surface.
	Pounds.	Feet.	Pounds.
I..........	11,413	1,259.5	9.06
A........................	16,361	1,205.0	13.57
R........................	18,850	1,731.0	10.89

The weight of the Class I boiler included water grates, whereas the others did not. It will be seen that it weighs 1.83 pounds per square foot of heating surface less than a Belpaire boiler, and 4.51 pounds less than one with crown-bars. In a boiler with 2,000 square feet of heating surface there would, therefore, be a difference of more than 3,660 pounds in the weight of a Belpaire boiler, and one of the Class I type and over 9,000 pounds between a boiler of the latter type and one with a crown sheet supported by crownbars. The comparison is, perhaps, not quite fair, for the reason that the Belpaire boiler was designed to carry a higher pressure than the others were intended for, but, after allowing for this, the fact remains that boilers of the camel type are lighter than any other form in use, and are easier to maintain, not slight advantages. As the objection is sometimes made to them that they do not carry water well, we made special inquiries with reference to that point. The testimony relating to this point was a little conflicting regarding the class I boiler which was probably deficient in steam room. Men who ran camel engines, and still survive, say that they always carried water very well. They had, however, high domes which were very large in diameter, and located at the front of the boiler near the front tube-sheet. If the only difficulty with boilers of this kind is that of carrying water satisfactorily it would, therefore, seem that it is remediable. The figures indicate that the capacity of a boiler of this kind, of a given weight would be about 20 per cent, greater than one of the Belpaire type, and the difference would be still greater if the comparison was made with one having crownbars. These are certainly no small advantages.

It is a curious fact that in piecing out flues in different shops in the country there are a greater variety of methods in use than are employed in doing any other kind of work. At Altoona there is one of the best equipped and most convenient flue shops that we know of. It is a large, well lighted and ventilated building apart from the boiler shop and just south of it. The flues when they are brought in to be pieced are first put into a "rattler," and the scale is cleaned off. The rattlers used here are cylinders of about 30 inches diameter, which are formed by bolting long cast-iron bars of T section to circular discs or beads attached to a suitable shaft. One of these bars is removable, and the flues are put inside of the cylinder through the opening which is left when it is removed. Between the others there are open spaces or slots about ⅜ inch wide. Formerly flues were rattled dry, but now the practice is to put them into the rattler with broken furnace slag and then conduct a stream of water, by a perforated pipe, which extends the whole length of the rattler—the water entering through the open spaces left between the bars. It is said that a given number of flues can be cleaned by the wet process in less than half the time than is possible if they are "rattled" dry.

After being cleaned the next step is to cut them off to the proper length, and scarf the ends of the flues externally, the piece to be welded on being scarfed internally. They are then driven together, heated in a coke fire and welded in a very simple machine, consisting in a revolving horizontal shaft which enters the inside of the flue. Another parallel shaft carries a roller, about 3 in. diameter and 2½ in. face, which can be raised and lowered in relation to what may be called the bearing shaft, and after the heated flue, which is to be welded; is placed in the latter, the roller is pressed down on the heated joint and the welding is effected in a few seconds. The two shafts are geared and revolve together. The machines are made by J. Sadler, of New York.

After being pieced in this way, the flues are tested in a hydraulic tester. This is arranged so as to fill the tube with water taken from the water supply. At the same time the water flows into what was originally a pump cylinder of a Westinghouse brake pump, containing a piston. The water enters the cylinder below the piston and raises it up. When the flue and the cylinder are filled the water connection is closed, and compressed air is admitted above the piston in the cylinder. This is proportioned so as to give the requisite pressure in the flue, and the test is thus made almost instantly. After being tested the flues are swaged down at one end, which is ground to receive a copper ferrule. This is brazed to the tube, and is in turn also ground on its outside surface. It has been found that when tubes leak, that the leak is more likely to occur between the tube and the ferrule, and not between the ferrule and tube plate, and that the brazing prevents such leakage.

Another method of putting in flues has recently been tested. This consists in putting the ferrule into the hole in the tube sheet and rolling it before the tube is put in. Afterwards the tube is put in and rolled inside of the ferrule.

This shop has a capacity for handling about 11,000 flues per month, the average output being about 8,000. All the work is done by piecework, as is the case in most of the shops in Altoona, which system is popular with the men and is profitable to the company. The general verdict is that there is no practical difficulty in securing good work by careful inspection, and that it is no more trouble to inspect work under the piece system than it is to inspect the men when they work by the day and keep them up to their duties.

The system of piece work has been very generally adopted in all the shops, even in round house repairs, and in such work as washing windows with the result of a great reduction in cost. The system is generally liked by officers and men and it would be difficult to induce the authorties at Altoona to return to the days work system after the experience they have had. It is said that the piece work system saves 65 per cent. on the cost of labor. There were of course at first many difficulties in introducing this method, one of the chief of which was, the making of a scale of prices, which took three years to perfect, and which now requires amendment at times. Besides the advantages named work is done quicker and can be hurried more than is possible when men are working by the day. In this way more work can be done with a given equipment than is possible with the old method. The inspection is done by the foreman or a special person appointed for that duty. It is upon the inspection that the success of the system of piece work is dependent. It is said that but little trouble is experienced from bad work.

One of the most interesting places in Altoona is the testing department and laboratory, which has acquired a world wide reputation. It occupies a three-story building 40 by 72 feet, located on the south side of the ground owned by the company. The chemical laboratory, under the charge of Dr. C. B. Dudley, occupies the whole of the third story and about half of the second, The first floor is devoted to the department of physical tests, under the charge of Mr. A. W. Gibbs.

The chemical laboratory is very fully equipped with every requisite for analyzing the great variety of materials which are bought and used in the operation of a great road like the Pennsylvania. The purchase of material by this company amount to many millions annually, and cover a great variety of substances, These include metals of different kinds, such as iron, steel, copper, brass, lead, zinc, etc., paints, oils, soaps, petroleum products of various kinds, caustic soda, blue vitrol, sal ammoniac, disinfectants, mineral wool, magnesia, boiler coverings, India rubber, etc., etc. The aim of those who conduct the laboratory is first to establish a standard of qualities which the material that is bought should possess, and then make specifications of these qualities by which they are bought, and to which they must conform. This alone has required an immense amount of investigation, study and research. At present about thirty-five specifications of this kind have been formulated, and all the materials to which these refer are bought to conform thereto. When the material is delivered samples are sent to the testing department, properly labeled, and designated by the number of the requisition under which it was ordered, and none of the material can be used, excepting in emergencies, until the samples have been inspected and analyzed to ascertain whether they comply with the specifications. As soon as the analyses are made reports thereon are sent to the superintendent of the motive power department, and the holders of the materials are duly notified whether it does or does not comply with the requirements. If it does it is accepted and used, if not the parties who supplied it are notified and it is returned to them. Some of the materials are subjected to both chemical analysis, and to physical tests before being accepted. The ascertainment of the qualities and characteristics, which all these different materials should have of course, implies as has been said an immense amount of special knowledge, and these which have been prepared were evolved as the result of the work of this unique department of the Pennsylvania railroad during the many years of its existence and are the results of much labor, research and experience. The great variety of materials which are bought by and are sold to railroad companies are, of course, subject to all kinds of deterioration, adulteration and falsification. Sometimes this arises from the ignorance of dealers or manufacturers; in others it is more culpable. It is the business of the testing department to ascertain whether the materials bought have the qualities required. There are, of course, some things which require only to be inspected, and not tested, and for that reason inspectors are employed, but these belong chiefly to the physical test department, and are sent whereever their services are required. That a private individual firm or a great company will be liable to be cheated if it does not know what kind of materials are supplied to it, or if its knowledge of what it gets is supplied only in a very casual, desultory and unsystematic way, would hardly uppear to require any proof. The Pennsylvania Railroad Company has organized its test department in a thoroughly systematic manner to do what every prudent business man does when he buys anything The magnitude of the transactions of the railroad company of course requires that the organization and scope of this department should correspond thereto in order to accomplish its purpose. In another article a fuller detailed description will be given of the work which has been and constantly is being done, with some reports of the results which have been accomplished thereby.

(*To be Continued.*)

Communications.

Sensational Tests of Car Weeels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

The interesting account on page 92 of your June issue of certain "thermal tests" of car wheels, made at Altoona, is calculated to excite alarm and to weaken confidence in cast-iron car wheels.

A little reflection will, I think, convince those who are familiar with the manufacture and use of car wheels that this test is entirely unlike any conceivable conditions, even of severest service. Prolonged action of brakes cannot approximate such a condition, although car wheels are frequently observed to be *very much hotter*, when examined at the bottom of a long descending grade, than your account shows sufficed to crack the test wheels, without any evidence of cracking in plate or brackets.

Pouring an annular lake of molten iron around the rim of a car wheel does not, at all, imitate the condition which obtains when brakes are suddenly and continuously applied, therefore no proper deductions can be drawn therefrom; though the *prima facie* reason why one wheel cracked under such a test and another did not, would appear to be that the cracked wheel had a deeper chilled tread and would, therefore, have proved a more serviceable wheel for the purpose for which it was designed, viz., to show good mileage in actual service.

Some years ago the wheels made at Altoona were cast by what was then called the "sand-flange process," and wheels cast in this way would, presumably, resist this extraordinary "thermal test" better than similar wheels cast in a chill not provided with the sand flange.

In 1881, when I last visited the Altoona shops, the sand-flange power process had been in daily use for more than five years and it would no doubt be equally applicable to contracting chills which are now generally used.

This process is simply providing a groove about ⅝ inches wide, ⅝ inches deep in the flange portion of a chill; this groove is filled with sand, properly packed to preserved the shape of the flange and an annular chamber about ⅛ inch wide and ½ inch deep with a few vent holes to carry off the steam generated in the sand rammed in the groove, while casting the wheel.

The practical effect of this arrangement was to decrease the chill of the flange of the wheel, without affecting the depth of chill on the tread. This difference would probably be sufficient to prevent the occurrence of a crack through the flange, which would, of course, immediately cause a crack in the brackets, followed by a crack through the plate.

I do not know whether the Altoona wheel was cast in this manner, or whether it was deficient in chill, but I regard the test as a sensational and misleading one, representing impossible conditions and likely to cause unnecessary alarm unless properly understood.

Not having been connected with car-wheel manufacture since 1887, I feel free to criticize this test. C.

[Our correspondent's observation that "the *prima facie* reason why one wheel cracked under such a test, and another did not, would appear to be that the cracked wheel had a deeper chilled tread," it is to be feared is a mere hypothesis, and may or may not be true, but is valueless as a basis for drawing any reliable deduction. Whether the wheels which were broken were or were not cast with a sand flange we are not able to say, neither do we know whether that method of casting "would probably be sufficient to prevent the occurrence of a crack through the flange." In cases like this it is well to keep in mind the maxim "that things which are not quite sure are very uncertain." Nor is it quite clear why the test referred to should be regarded as "sensational." That car wheels break when their rims are suddenly heated to comparatively low temperatures is surely a fact of importance in view of the experience, which is not uncommon, of more or less mysterious breakages of wheels in service, attended at times with loss of life or limb, and always by loss of property. It would or should be more sensational if such a fact did not receive very serious consideration by those who are interested with the responsibility of carrying us safely when we travel on railroads.—EDITOR.]

Indicator Rigging for Locomotives.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

There is a mistake in the latter part of the article in your June issue on the Indicator Rigging used on the Pennsylvania Railroad, where it is stated that the rigging illustrated is the development of one used by Professor Goss, whereas it is the development of one first used and illustrated by Mr. Dean or George Strong.

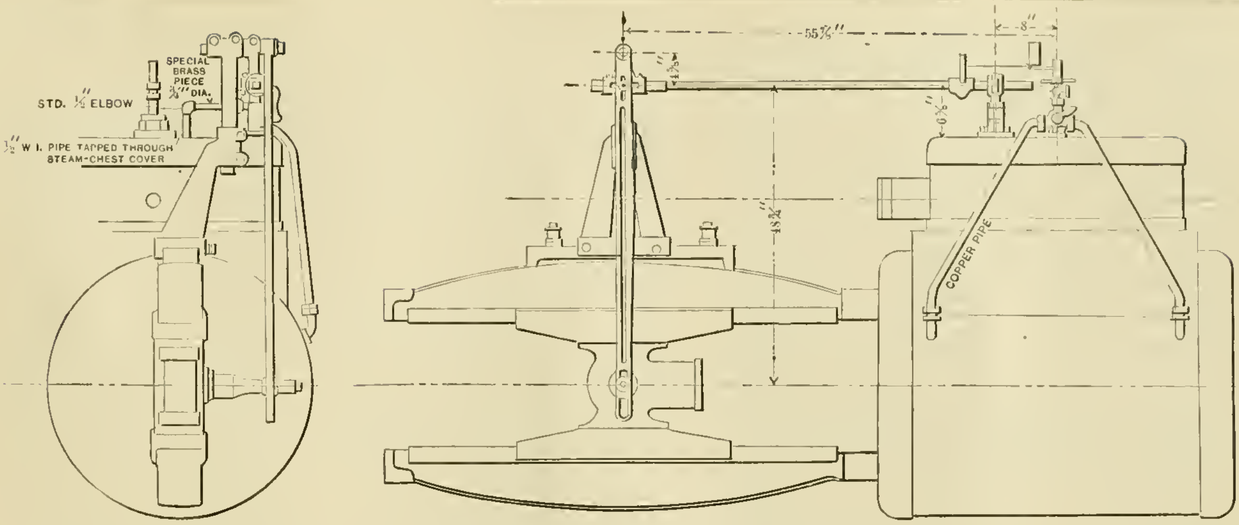
I send you with this letter prints showing the general arrangement and details of our latest rigging, which is a modification of that used by Professor Goss. It was made for use on our new mogul compounds, as the pantograph rigging was not adapted to the increased stroke and higher steam chests of the compounds. The pantograph rigging is an accurate one and has been used at speeds over 80 miles per hour, but service has shown it to possess two disadvantages:

First. The workmanship has to be very excellent to prevent lost motion.

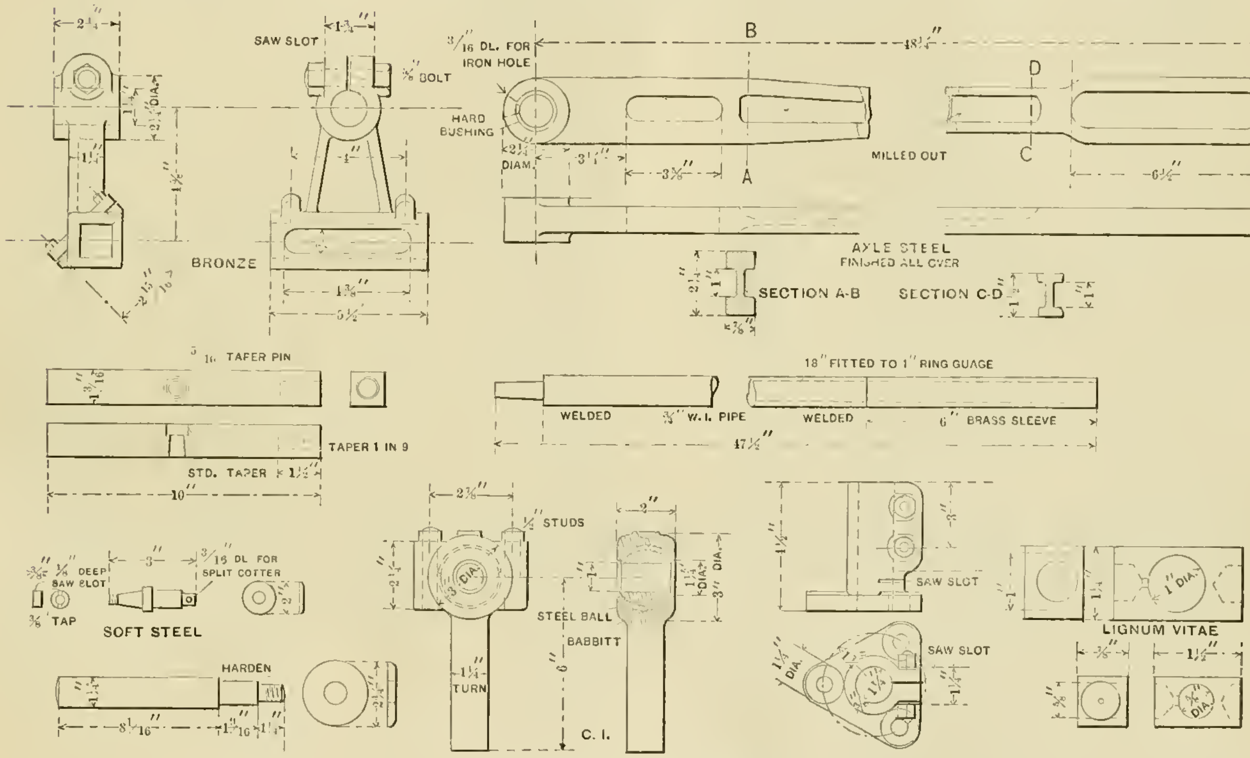
Second. It is too flexible laterally, and the side tremors set up are communicated to the motion rod, and thence to the indicator drum.

The motion shown in the blue prints sent you is an equally accurate and much simpler one, and, as will be noticed, uses several parts of the pantograph motion.

Trial shows that it wears better and is not subject to the same vibration as the other motion, but has not the same range of vertical adjustment. It has provision for taking up the wear where necessary, and the steam-chest bearing for the motion rod is much



General Arrangement of Indicator Rigging.



Details of Indicator Rigging.

better than that illustrated by you in June. Brass sliding blocks in the slots of the lever were found to wear too fast, and have been supplanted with others of lignum vitæ, which wear very much better. The details are so plain as to need no explanation.

For engines with a short stroke and high steam chests, the fulcrum of the lever could well be placed between the slots, and would allow a much shorter and stiffer stand, but the angle of the slots to the line of motion would be less favorable, and there might be some trouble from sticking.

In conclusion, I think that where it is necessary to adapt one rigging to a number of engines of different types, the pantograph motion is to be preferred, but where one can afford to make special levers of different lengths, the one shown is most satisfactory.

Yours truly,

A. W. Gibbs,

Assistant Mechanical Engineer, Pennsylvania Railroad, Altoona, Pa.

[The prints reproduced herewith need but little explanation. The lever is shown in detail, also the lignum vitæ sliding blocks. The lever fulcrum and means for adjusting it are much the same as in the illustrations in our June issue. The fulcrum pin is clamped firmly in the fulcrum and between the latter and the lever is a motion-rod guide clamped to the same pin. It provides a support for the square end of the motion-rod, and the square end, which is 10 inches long, is drilled for a pin which also passes through the sliding block in the lever. The support for the motion rod at the steam-chest end consists of an adjustable standard with a steel ball in a babbitted socket, the rod passing through a hole in the ball. The method of attaching the cord is the same as in the other rigging.

This rigging and the one previously illustrated are two excellent examples of serviceable rigs, the one illustrated in June being adjustable to a number of locomotives of different dimensions, while the one here shown is simpler and has fewer parts, but is not adjustable to the same extent as the former one. It would probably require a new lever for each class of engine, all the other parts being retained. But as Mr. Gibbs has pointed out, it is a better rig than the pantograph, and while the cost of several levers may be raised as an objection, it should be remembered that the cost of keeping lost motion out of the pantograph will in a measure offset this expense where much indicating is done. —Editor.]

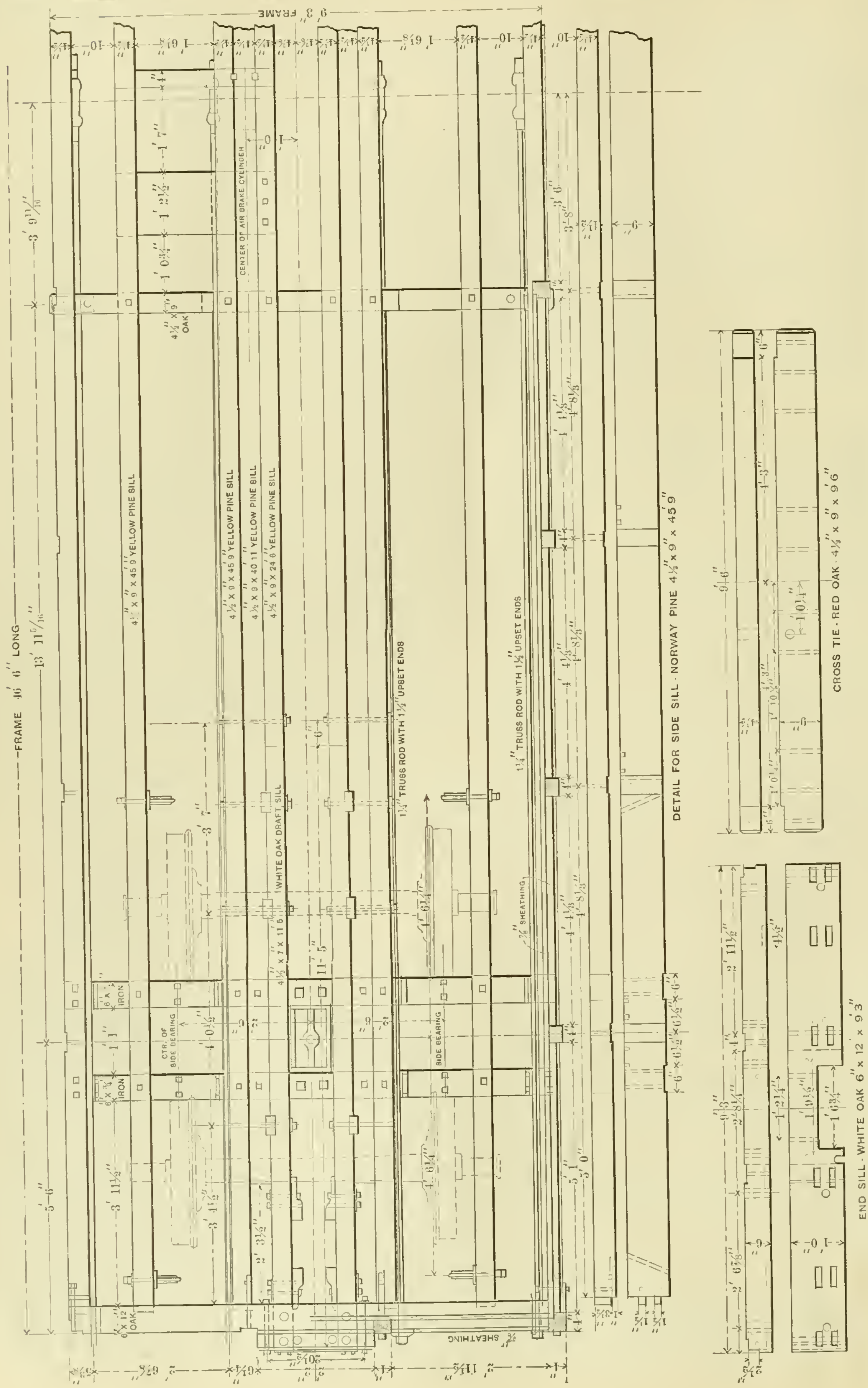


FIG. 1.—UNDERFRAME OF FORTY-SIX FOOT FURNITURE CAR—CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Designed by Mr. J. N. Barr, Superintendent of Motive Power.

Forty-Six-Foot Furniture Car—Chicago, Milwaukee & St. Paul Railway.

To meet the need for a furniture car of large cubical capacity on the Chicago, Milwaukee & St. Paul Railway, Mr. J. N. Barr, Superintendent of Motive Power, designed a car, the drawings of which, through his courtesy, we present to our readers. Its inside dimensions are 46 feet in length, 8 feet 9 inches in width and 9 feet 3 inches in least height, and the capacity in weight is 60,000 pounds.

The car is remarkable for its size, though there have been constructed furniture cars 50 feet or more in length; but usually the cars of extreme length have a capacity of less than 60,000 pounds. The most interesting part of this car, however, is the framing, which, upon inspection, will be found to differ from common practice. In the underframes the arrangement of sills is novel. Ordinarily the longitudinal members of a frame for a car of this size would consist of eight sills and two draft timbers backed by sub-sills under the center sills to make them practically continuous. In this car there are the same number of longitudinal members, but, as is clear from Fig 1, they are all in the same horizontal plane. The draft timbers are placed against the inside faces of the center sills, and against the outside faces of the latter are placed the first intermediate sills. This arrangement brings together in one mass, on each side of the center, three $4\frac{1}{2}$ by 9-inch sills, which extend throughout the length of the car, except that, what we have termed the center sills, only extend to within 2 feet $3\frac{1}{2}$ inches of the inside face of each end sill. All the sills proper are of yellow pine, and the draft timbers are of white oak and 11 feet 5 inches long, which causes them to extend well beyond the body bolster. From back to back of end sills there are made continuous $4\frac{1}{2}$ by 9-inch yellow pine sills. The end sills are 6 by 12 inches in section and at the center are cut out, not only for the drawbar stem, but also for the ends of the draft timbers.

By this arrangement the only vertical bolts holding the draft timbers are those through the end sills and deadwoods. It is not necessary to enter the car to remove any of the bolts, but all of them are accessible from the outside. The space between the two intermediate sills is sufficient to permit of the entire withdrawal of the long horizontal bolts extending through the three timbers. The bolts of the draft lugs pass through the draft timbers only, and their nuts are accessible in the pocket or opening occasioned by the short center sills. The construction described not only facilitates the removal of the draft timbers, but it is believed that will also make it easy to replace a center sill.

The body bolsters are of iron and double. Each truss consists of a 6 by $\frac{5}{8}$-inch upper plate and a 6 by 1-inch lower plate. At the center a large casting extends between the trusses to receive the center plate. The needle beams are $4\frac{1}{2}$ by 9-inch oak. The frame is trussed by four $1\frac{1}{4}$-inch truss rods, with $1\frac{1}{2}$-inch ends.

The upperframes are also worthy of attention. All the posts on the sides and ends of the car project slightly through the outside sheathing of the car. They are not tenoned and mortised into the top faces of the sills, but extend down their sides and are secured by horizontal bolts, in addition to the usual vertical tie rods. It will be noticed that the sills are gained $\frac{1}{2}$ inch deep for the posts. These posts are 3 by 4 inches in section, except at the doors and corners, where they are 4 by 4 inches. At the lower end they are cut away so as to leave a foot $1\frac{1}{2}$ inches thick which fits into the gains in the faces of the sills. The upper end is joined to the plates in the same manner. A detail of one of the door posts is given in Fig. 3. The diagonals are of 6 by 2-inch oak and are set into iron shoes at each end. There are two white oak belt rails, each 3 by 3 inches in section. By the construction of the posts, as here shown, there are no tenons and mortises to rot, and repair or replacement of members of the side end framing can be more easily performed and with less disturbance to adjacent parts than in the common construction. It also gives more width inside of the car for a given outside width, because one inch of the side posts is outside of the sills, and the outside sheathing does not cover the post, thus the total gain being about 2 inches. The car is 8 feet 9 inches wide inside, 9 feet 3 inches wide over the sills, 9 feet $4\frac{3}{4}$ inches over the sheathing, and 9 feet 11 inches wide over the eaves.

The trucks for these cars are of the Barber type, patented by Mr. J. C. Barber, formerly Master Car Builder of the Northern Pacific Railroad. They are shown in Fig. 4. The frames are of the diamond type, and carry the springs by means of seats on the bottom arch bars between the column guides. Above the springs are caps separated from the bolster ends by rollers. The upper

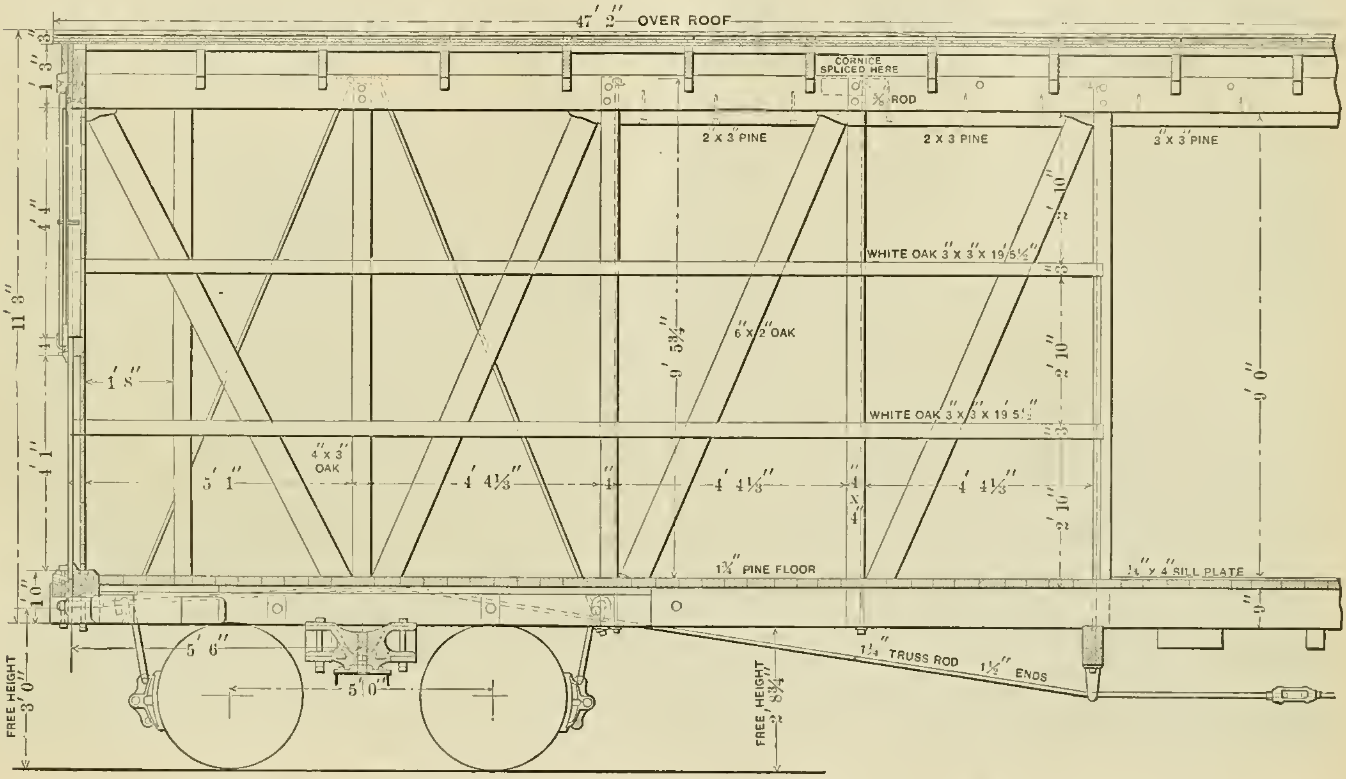


Fig. 2.—Framing of Forty-six Foot Furniture Car.—Chicago, Milwaukee & St. Paul Railway.

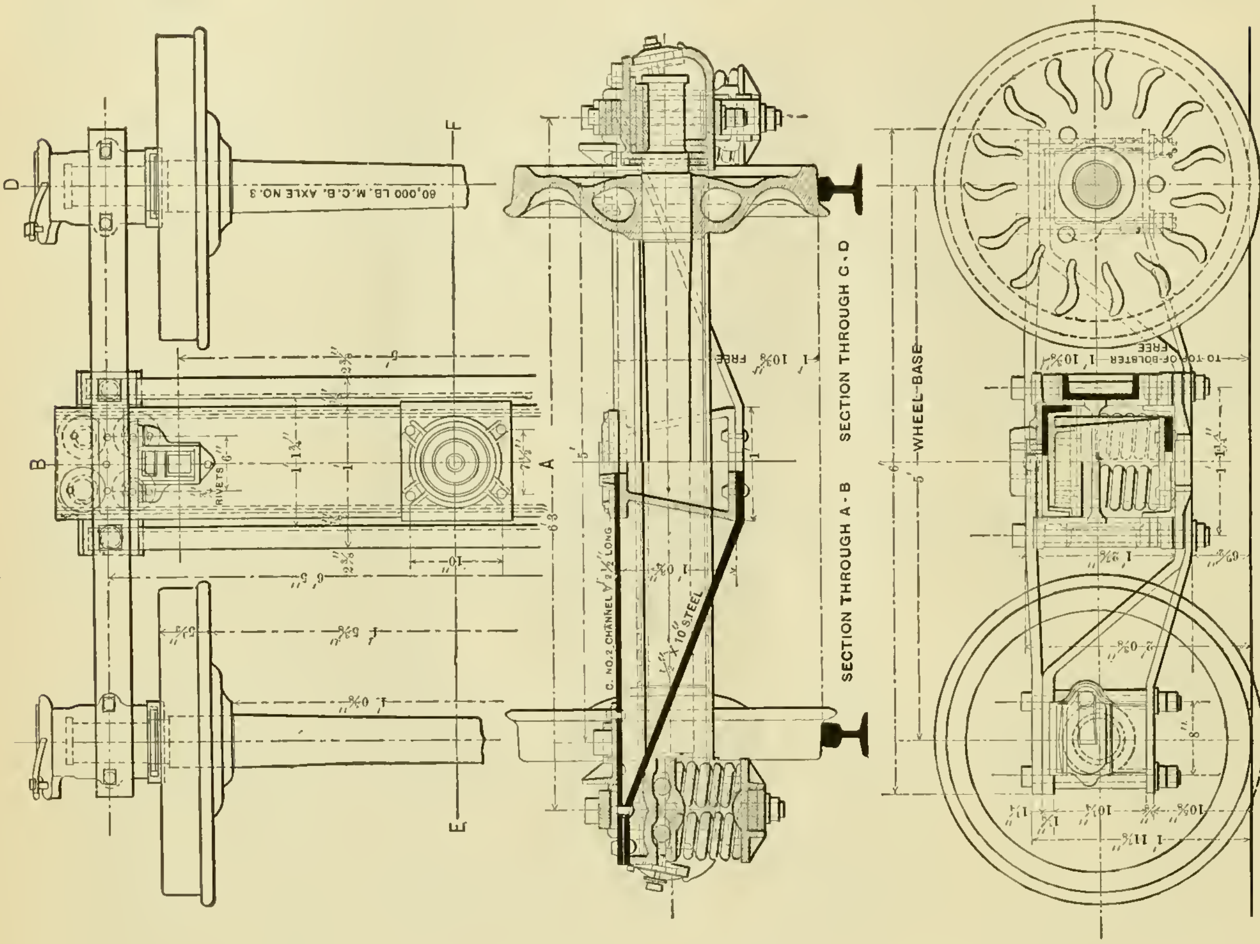


Fig. 4.—Truck for 46-Foot Furniture Car.

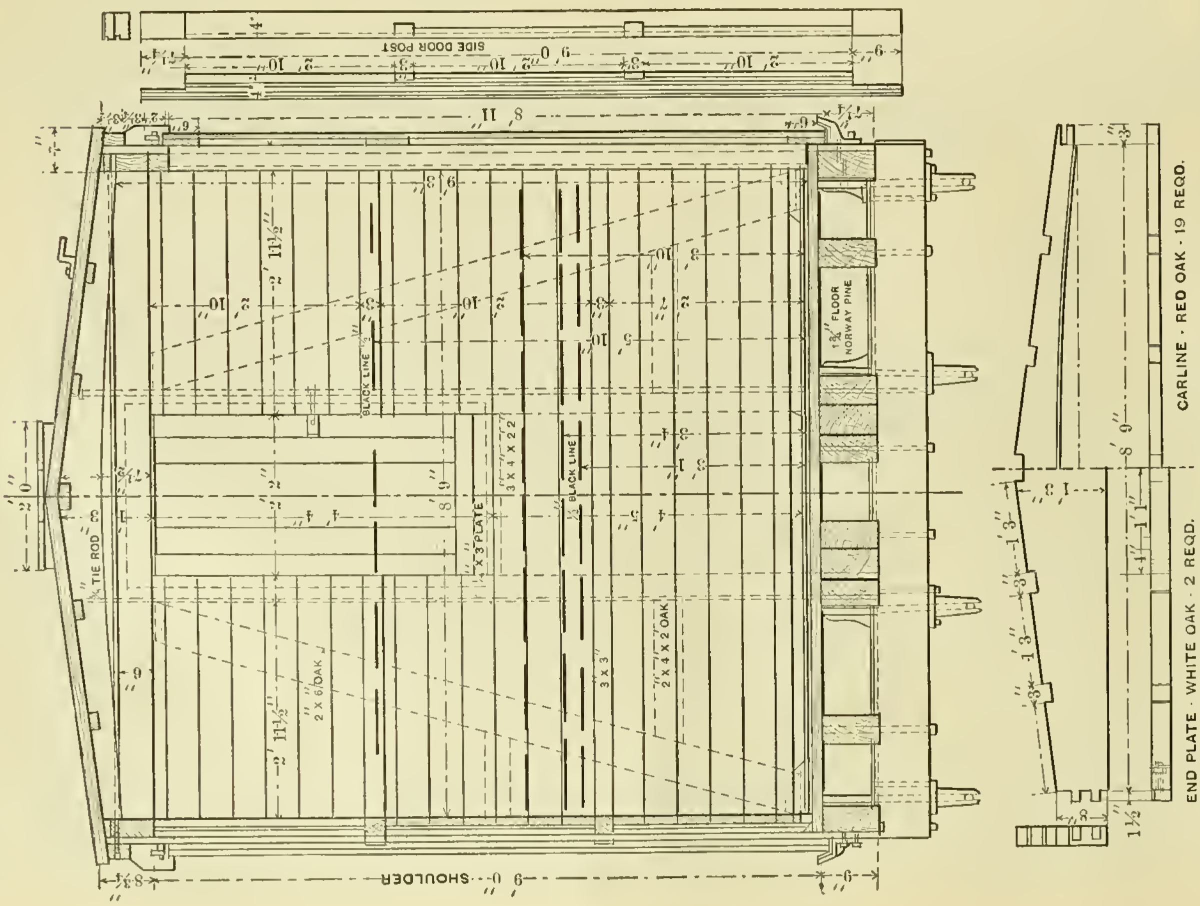


Fig. 3.—Cross-Section of Furniture Car.

Chicago, Milwaukee & St. Paul Railway.

and lower surfaces in contact with the rollers are dished. On top of the bolster are brackets $1\frac{1}{16}$ inches inside of the frames, which serve to limit the lateral movement to a total of $2\frac{1}{8}$ inches. Thus a swinging or laterally moving bolster is provided without resorting to swing links and pins, spring planks and the numerons accesories of that arrangement.

The bolster is metal, the top member being a channel and the lower one a plate, the two being riveted together at the ends. The truck is held square by two 8-inch channel transoms, as shown. These channels are light, for they do not carry any part of the load. The entire truck is of excellent design, and particularly so considering that it is very low, the seat for the center plate being only $22\frac{3}{8}$ inches from the rail when light.

Pittsburgh Compound Locomotive for the Lake Superior & Ishpeming Railway.

The Pittsburgh Locomotive Works have recently built a heavy compound consolidation locomotive for the Lake Superior & Ishpeming Railway. Through the courtesy of the builders we have been furnished with a photograph from which the accompanying cut was made. The engine of the two-cylinder type and the compounding is on the well-known design of the builders. It is intended for heavy service, as is evident by the weight of the engine and the boiler and cylinder power furnished it. The boiler is 64 inches in diameter at the front end, 67 inches at the back head, is of the straight type, carries 180 pounds pressure, and has 2,198.1 square feet of heating surface and 31.78 square feet of grate area. The cylinders are 20 and 31 inches in diameter and 28 inches stroke. The leading dimensions of the engine are as follows:

Fuel	Bituminous coal
Gage of track	4 feet 8½ inches
Total weight of engine in working order	147,600 pounds
" " on drivers	132,800 "
Driving wheel base of engine	15 feet 6 inches
Total " " " "	23 " 6 "
" " " " " and tender	52 " 10½ "
Height from rail to top of stack	14 " 11¼ "
Cylinders, high pressure, diameter and stroke	20 inches by 28 "
" low " " " "	31 " " 28 "
Slide valves	Richardson balanced
Piston rods	Steel, 3¾ inches diameter
Type of boiler	Straight
Diameter of boiler at smallest ring	64 inches
" " " " back head	67 "
Crownsheet supported by radial stays	1⅛ inches diameter
Stay bolts	1 inch diameter, spaced 4 inches from center to center
Number of tubes	240
Diameter of tubes	2¼ inches
Length of tubes over tube sheet	14 feet 7 inches
" " firebox, inside	108 inches
Width " " "	42⅜ inches
Working pressure	180 pounds
Kind of grates	cast iron, rocking
Grate surface	31.78
Heating surface in tubes	2,049.5
" " " firebox	148.6
Total heating surface	2,198.1
Diameter of driving wheels outside of tire	56 inches
" and length of journals	8 inches by 9 inches
" of truck wheels	30 inches
" and length of journals	5 inches by 9 inches
Type of tank	Level top
Water capacity of tank	4,000 U. S. gallons
Fuel " " "	280 cubic feet
Weight of tender with fuel and water	76,200 pounds
Type of brakes	Westinghouse American automatic

Compound Consolidation Locomotive for the Lake Superior & Ishpeming Railway.
Built by the Pittsburg Locomotive Works.

Subjects and Committees for the 1897 Convention of Railroad Air-brake Men.

The subjects of reports to be read and discussed at the next annual convention, and the names of the members of the committees to which each subject has been assigned, are as follows:

"Air Pumps. Their Troubles and Treatment, and Tools for Making Repairs."—Otto Best, chairman; Alex. B. Brown, H. F. Bickle G. S. Hale, Jno. Hume, Jr., C. P. Cronin, Fred Hain.

"Proper Piping for Locomotives, Tenders and Cars."—R. H Blackall, chairman; W. F. Drodnax, J. R. Alexander, Geo. Gregory B. F. Hudson, Robt. F. McKenna, L. E. Hopkins.

"Round House Tests of Air-brake Equipment on Locomotives and Tenders "—R. C. Cory, chairman; Isaac McKeever, Robert Burgess, A. J. Gosselin, L. S. Hawkes, Robert Wark, C. B. Conger.

"Best Methods of Locating and Repairing Defects in Air-brakes, Occurring on Trains En Route."—Geo. R. Parker, chairman; C. S. Hall, Henry Brown, Edw. W. Pratt, I. H. Brown, W. R. Harper, T. A. Hedendahl.

"Best Location for the Air Gage Where It Can Be Seen by Night and Day."—C. P. Cass, chairman; W. P. Steele, W. S. Heckman, E. G. Desoe, C. F. Schragg, T. J. Mendenhall, Geo. Holmes.

"Shop Tests and Repairs for Triple Valves."—Wm. Malthaner, chairman; F. M. Tiffany, W. A. Spencer, W. A. Garaghty, F. B. Farmer, C. A. Sanders, Eric Kronberg.

"The Retaining Valve and Its Uses."—W. I. Steele, chairman; F. R. Spalt, H. C. Frazer, C. L. Johnson, M. E. McKee, George W. Fairchild, J. K. Lencke.

"Foundation Brake for Locomotive Tenders."—W. H. Durant, chairman; W. F. Brodnax, F. M. Nellis, C. C. Farmer, John Roney, T. Warren Dow, Eugene McAuliffe.

Committee on Arrangements.—F. M. Nellis, chairman; Otto Best, Lawrence Hahir, W. C. Walsh, J. A. Jesson.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.—Second Series.—Chemical Methods.

XLX.—Method of Determining the Shade of Paints.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

EXPLANATORY.

Perhaps no characteristic of paints gives more trouble, both to the manufacturer and to the consumer, than the shade. To the uninitiated, red paint is red, green paint, green, and blue, blue; but the person who attempts to make a sample of paint which shall match any given color, be it red or green or blue or any other color, either with or without a name, soon finds that there may be hundreds of shades of what is commonly known as one color, and that only one of these is an exact match for the color he has in hand. Oxide of iron, as is well known, is commonly said to be red in color, but the number of shades of the red of this pigment are almost as numerous as the different sources from which it is obtained. Each mine of this material used as a pigment apparently has its own shade, and each batch of artificially made oxide of iron, so far as our experience goes, differs more or less in shade from every other batch. The truth of this statement may be very easily verified by obtaining samples of the various colcothars, crocus martis and cheaper grades of Indian and Venetian reds in the market, most or all of which are artificially prepared, and compare them for shade by the method described below. The results obtained, we are confident, will fully justify the statement made at the beginning of this article.

The method of producing the shades desired in pigments is twofold; first, by varying the conditions under which the pigments are produced in the manner known to color makers; and, second, by means of mixtures. The latter is obviously the method that must be used by the color grinder, and the painter or consumer. But in order that the color maker, the color grinder or the painter may know what he is doing, or when he has secured the desired result, it is obvious that he must have some method of determining shades. Furthermore it is well-known that large amounts of paints are used by railroads for a definite purpose, such as painting freight cars or passenger cars, or for buildings and fences along the line. These paints have definite shades, established after considerable care and study. They are, many of them, bought on definite specifications, and always in successive shipments, and from different manufacturers. There must, therefore, be some method conscientiously used of determining the shades of these various shipments, or the utmost confusion and mixture of colors will result. It is the object of the present article to describe such a method.

Several ways have been suggested and employed with more or less success in determining the shade of paints. They are all based, at least so far as our experience goes, on comparison of the sample in hand, with some other sample which represents the shade desired. This comparison has been made in three ways:

I. Since the end desired, viz., that the painted work when finished shall be of the required shade, perhaps the most natural and most universally employed method of determining shade, has been to have previously prepared a small board or other surface painted with the standard or desired shade, and compare this with a similar one painted with the material whose shade is in question. The comparison is usually made by placing the two boards side by side and examining them at different angles and in different lights. This method has been very largely used, and was for a long time, perhaps, the only one in general use. It has the advantage mentioned above of enabling the judgment in regard to the paint in question to be based on the finished work, and this is unquestionably a very strong point in its favor, but the disadvantages of this method are also very great, so much as to render it almost impracticable for testing successive shipments. These disadvantages may be briefly enumerated as follows: *First.* Paint when it is freshly applied does not always have the same shade that it does when the same paint is dried, owing, perhaps, to change of position of some of the constituents of the pigment during drying, and possibly to chemical changes between the oil and pigment during the same operation. Both these phenomena are known to occur during the drying of paint, and both are known to affect the shade. Moreover, differences in surface, viz., the glossy surface due to the liquid, or the more or less dead surface due to dried paint, have an influence on the shade, so that it is clear that unreliable results will be given by comparing a freshly painted surface with the standard dried sample. If this method of determining shade is used, therefore, it is evident that the paint to be tested must be allowed to dry before comparing with the standard, or some of the standard must be freshly mixed each time, and the comparison made on the undried paints. The former requires far too much time for successful use in testing shipments, and the latter is laborious and moreover sacrifices the strong point of this method, viz., a judgment obtained from the finished work. It should be stated that in common use the standard is prepared once for all, and is kept, sometimes without exposure to the light, but more commonly hanging on the wall in the shop. This leads us to the *second* objection to this method, viz., the standard changes with time. The change in paints which results from exposure to the light, the air and to the action of water is far too well known to require especial comment, and while it is quite possible to exclude the action of water on the standard board, and by proper and reasonable protection to diminish the action of light, it is still, we believe, impossible to prevent any paint, and especially those containing organic coloring matter, from slowly fading. A *third* objection to this method, at least if the dried standard is used, is that the various ingredients used in mixing the paint affect the shade. This is especially true of the japan drier, which, as is well known, is dark in color, and also by its action on linseed oil changes that to a dark color. In order to make a fair comparison, therefore, with the dried standard, it would be essential to use the same amount of the same japan, since japans differ widely in their composition, as was used in preparing the standard board. It needs no extended comment to make clear how difficult this would be. *Fourth*, and finally, this method does not give very sharp results, that is, does not enable fine distinctions in shade to be made. Inequalities and irregularities in the surfaces, the difficulty of getting the light to strike the two samples at exactly the same angle, and especially the absence of any sharp line of demarkation between the two, all conspire to render the indications obtained by this method general, rather than sufficiently definite to enable the operator to do justice to both producer and consumer in his tests.

II. A second method of determining shade, which has been tried somewhat, is by means of the Lovibond tintometer. This instrument may be briefly described as a flat wooden tube, open at both ends, about 14 inches long and 3 inches broad and an inch and a half thick. At one end a partition divides the tube lengthwise for a short distance. At one side of the partition are arrangements for holding small colored glasses, and on the other side, arrangements for holding the sample to be examined. The instrument is used by placing the material to be examined so that the light will pass through or from it on one side of the partition to the eye looking into the other end of the tube, and then placing a pure white surface on the other side of the partition, so that light from it will pass to the other eye. Now a series of colored glasses of varying colors and strengths being introduced between the white surface and the eye, it is possible under favorable conditions to get the same color that the sample to be examined shows. The glasses being numbered and marked according to a previously arranged nomenclature, it is possible to, in reality, make an analysis of the color which is being worked on. It is obvious that as applied to determining the shade of paints, it is only necessary to make an analysis of the standard sample, and then see if the successive shipments give the same analysis. Our experience with this instrument has not been very large, but we have experimented with it enough to find as follows: *First.* The source from which the light comes, makes considerable difference in the analysis. It is recommended to use the instrument in a "perpendicular light from a dull gray sky." But such light is not always available, while the testing of shipments must go on, whether good light is available or not. This difficulty, therefore, is quite a serious one. *Second.* Different operators are not able to make the same analysis, all other conditions, being as far as possible, the same. Indeed, the same operator, using one eye at a time to make an analysis, will not get the same results with both eyes. It is obvious that this difficulty, might lead to serious trouble, if the analysis by test of the consumer, led to the rejection of a shipment, while the analysis by the expert of the shipper showed that the material passed test. *Third.* The analysis of the standard even under favorable conditions is slow and laborious, and while, with sufficient time and care, close results and fine distinctions can be made, it would be quite out of the question to make an analysis of the standard and of sample from shipment each time the instrument was used. This procedure would probably eliminate the two difficulties mentioned above to a greater or less extent, but such a procedure would require more time than could be given for determining shade. We are far from saying that such modifications and fixing of conditions cannot be introduced into the tintometer as would make it entirely a practicable instrument for determining shades, but our studies have not yet led us to such results.

III. The third method of determining shades which we have had experience with is described below:

OPERATION.

Have the pigment representing the standard shade in the dry condition, that is unmixed with oil or any other menstruum. Then if the material to be tested is in the dry condition likewise, weigh into an agate mortar a gram of the standard, and add as much pure fresh raw linseed oil as will form with the pigment a stiff paste. Rub with the pestle until the paste will stand a previously decided upon test for fine grinding. A satisfactory method of testing fineness of grinding is described under the heading, "Method of Determining the Fineness of Grinding of Freight Car and Paseenger Car Colors," published in the June number of this journal. Mix the same amount of the material to be tested with the same amount of oil used with the standard, and rub with the pestle to a condition as to fine grinding at which it is desired to know the shade. Now, with a spatula or glass rod, transfer a little hillock of each of the samples of paste to a small piece of clean glass, placing them near each other. Lay on top of the two hillocks a thin cover glass, such as are used by microscopists, and press it down until the two samples unite. If they are of exactly the same shade, there will be no line of demarkation between the two. If they differ in shade, this line will be more or less clearly marked. If the material to be tested is in the paste form, or mixed with any menstruum whatever, it is essential to mix the standard pigment with the same amount and the same kind of menstruum as is characteristic of the material to be tested before the comparison is made. Also the fineness of grinding of the standard must be that previously determined upon, otherwise the operation is in all respects the same as that described for dry pigments.

APPARATUS AND REAGENTS.

An agate mortar is best for preparing the samples for testing, but a porcelain mortar or other means of mixing the oil and pigment and bringing the paste to the proper fineness can be used.

Strips of ordinary glass may be used to put the hillocks of paste upon, but for the cover it is essential to have the glass thin and as free as possible from color, since the color of the glass affects the shade. What are known in the market as "microscope slide cover glasses," about three-quarters of an inch in diameter and as thin as possible, work very nicely.

In regard to menstruum, pure raw linseed oil, not too old and fatty, and of clear amber color, is best. Oil that is discolored from any cause should not be used.

CALCULATIONS.

Obviously no calculations are required by this method.

NOTES AND PRECAUTIONS.

It will be observed that this method is simply a comparison of the material to be tested with a previously decided on standard, under certain definite conditions.

The shade of paints is affected quite considerably by the fineness of the particles of the pigment, and also, apparently, by the intimacy of the mixture of the pigment with the menstruum. The shade of some pigments, notably scarlet lead chromate, is very perceptibly changed, or, indeed, almost destroyed, by fine grinding; other pigments develop their most desirable shades only when finely ground, and all pigments, so far as our experience goes, vary their shades more or less according to the fineness of the grinding. It is obvious, therefore, that some standard of fine grading must be established before a standard of shade can be decided on. The pigments of paints to be compared with the standard may or may not be brought to the same fineness as the standard, according to the information desired from the test.

The shade of pigments is often so completely changed by mixing with some menstruum that no satisfactory results can apparently be obtained by comparing dry pigments. A very good illustration of this may be secured by comparing white lead and sulphate of lime or gypsum, both dry and ground in oil.

With some pigments a change in shade occurs during the first 12 hours, after mixing with the oil, so that if the standard is mixed and the comparison made immediately the same result will not be obtained as if the standard is allowed to stand 12 hours after mixing. As the principal use of the test is to see whether successive shipments of ground material have the standard shade, it is essential with these pigments to mix the standard and allow it to stand at least 12 hours before making the test. We are unable to explain the change in shade of the standard which results from standing. The change is beyond doubt.

The pigment representing the standard shade should be kept in a place free from moisture, and, as previously stated, should not be mixed with the menstruum until needed for use. All attempts to keep a standard shade in any other way have, so far as our experience goes, resulted in failure, while with many pigments this method gives entirely satisfactory results. It is possible that some pigments, even in the dry condition, will slowly change in color; many, if not all, certainly will if mixed with oil or other menstruum and exposed more or less to light and air.

The principal use of this method being, as previously stated, to test shipments of material bought in the paste form, and on definite specifications as to proportions of pigment and liquid and as to fineness of grinding, a very large number of tests can be made in a day. In describing the method an attempt has been made to give it a little more general application.

It may be urged as a defect of the method that it tests the material at a point in its history so far away from the finished work that really the consumer is hardly fairly dealt with. But as has already been shown the materials which the consumer adds to the paint to enable it to be spread, change the shade, and it certainly cannot be fair to hold the manufacturer responsible for what the consumer does to change the shade. Moreover, when testing shipments, as is seen, the test is applied at that point in the transaction where the material passes out of the control of the producer and into the hands of the consumer, a very fitting place, it would seem, to apply all tests and decide all questions affecting the material.

It will be observed by those who make tests in the manner described above, that the material to be tested either is the same shade as the standard, or it is not, and there is no means of accurately telling how near any given material is to the standard shade, nor without experiment to say what to do to the material under test to bring it to the standard shade. In other words, since commercial materials are rarely in any respect exactly what is aimed at, and since with all materials small variations from the requirements of the specifications are allowed, it may seem that a method so rigid as this one would be inapplicable. It was hoped that the tintometer would enable this difficulty to be met by making it possible to say how much any material might vary from standard shade and still be acceptable. As already stated, this has not yet been found to be possible. In actual practice what is done is to accept shipments that come very close to the standard and reject those farther away. The method described above is extremely delicate, but after a little experience is obtained in its use it is not difficult to use it in such a way as to do no injustice.

Mill Heating from the Hot Well.

In a paper read before the New England Cotton Manufacturers' Association, Mr. George W. Weeks described a novel method of heating employed in one of the buildings of the Lancaster Mills, Clinton, Mass. The building is 116 feet × 109 feet × 74 feet high, with about 60 per cent. of the wall area occupied by window openings, none of which were supplied with double windows. The heat for warming the building is obtained from the water discharged from the hot well of the compound engine that furnishes the power, while the air heated is put in motion by the flywheel of the same engine. The system has been in use four winters. Mr. Weeks says:

After consulting with Mr. H. S. Robinson it was decided to put in on trial his system of heating air by means of water from the hot well of engine and add thereto a small engine and blower for use nights and Sundays when the large engine was not running.

The ordinary Corliss flywheel would force sufficient air for this purpose without alteration (we find the air pressure in one of our Corliss wheel pits to be equal to 1½ inches of water), but the wheel of the Wright engine used in the mill being made with arms so shaped as to pass through the air with the least resistance, we found it necessary to add "wings" to them. This wheel is 16 feet in diameter and runs at a belt speed of 4,000 feet per minute. After the wings were attached we obtained a movement of 8,000 cubic feet of air per minute through the flues and mill with an expenditure of three horse-power, as shown by the indicator.

The air is taken mostly from the basement, where it enters from out-of-doors and largely from the connecting boiler-house.

The heater is situated in the air duct leading to the flue, and consists of eight sections, each 42 inches high by 28 inches wide, with 204 ½-inch pipes, each 90 inches long. These sections are connected by pipe with the hot well, and so arranged that the end covers and diaphragm causes the hot water to flow by gravity through half of the pipes in one direction and return through the other half, and then continue through the other sections in the same manner, and discharging where the air enters, so that the air is always coming in contact with hotter water.

Small pipes were used in order to obtain the largest amount of heating surface in a given space, but as we find we have more heating surface than is needed, it would have been better perhaps to have used larger and fewer pipes so as to offer less resistance to the passage of the air.

With water from hot well at 115 degrees Fahr., we heat the air to 100 degrees Fahr. In one test air was taken directly from out of doors at a temperature of 26 degrees and sent to the mill at 107 degrees, with water taken from hot well at 123¼ degrees and discharged from heater at 97½ degrees. We find in practice that the air is heated to within about 10 degrees of the water used.

As stated before, we put in a small engine, fan and blower to heat the mill before the large engine was started, and to heat it also nights and Sundays during the winter. It would have been cheaper to have put in steam pipes in the old way, and if one does not object to pipes the expense of the extra engine and blower may be saved.

While heating the mill in December, before the large engine was started, we ran the fan engine, exhausting the steam in the same heater. After the large engine started we drove the fan by belt from this engine, and while the walls were still wet, the mill having just been completed, we forced 12,000 feet of air per minute into it, this being sufficient to heat it while in that condition. This required 8.81 horse power, as shown by indicator on engine. As soon as the "wings" were put on the arms of the flywheel we started the air from that, and, as stated before, we heated the mill with 8,000 cubic feet of air per minute, as the looms were nearly all then in operation, and we found that to be sufficient. It took 3 horse power only to furnish this air from the flywheel.

We did not rig up to run the "blower" at a speed to force 8,000 feet per minute, but judging what it would take from the 12,000 feet, it would doubtless require 5¾ horse power to force 8,000 feet, or nearly double that required by the flywheel.

We find that it requires about double the heating surface to heat with water that it does to heat with steam, but as water heaters have to sustain no pressure, they can be furnished for a very little more than steam heaters made in the usual way.

Hot or cold water can be showered into the duct in the usual way when desired. When the weather becomes warm enough, so that no heat is required in the mill, the water from the condenser is turned off, and the engine flywheel continues to force the same amount of air through it for ventilating and cooling, and for this latter purpose we can turn cold water through the pipes in the same manner as water from the hot well.

During the time this plant has been used, it has required no repairs and has demonstrated that it will heat and ventilate the mill during the running hours with no expenditure for steam or power beyond the three horse-power added to the engine as stated; that 100 degrees temperature is sufficient to satisfactorily heat the mill, and that the air can be heated to this temperature, with water from the hot well with no loss of power, and our experiments tend to show that it is more economical (when the uptakes are built into the walls) to send a larger amount of air at a lower rather than a smaller amount at a higher temperature. Air heated to 97$\frac{7}{10}$ degrees at heater is delivered to the fourth story at 94½ degrees, showing a loss of only 3$\frac{2}{10}$ degrees, while air at 124 degrees at the heater was delivered at the fourth story at only 113, showing a loss of 11 degrees.

The Freight-Car Repair Shops of the Southern Pacific at Sacramento.

The Sacramento *Weekly Union* has been publishing an entertaining series of shop notes relating to the car shops of the Southern Pacific at Sacramento, and the last one gives the following facts regarding the freight-car repair shops:

"The shop itself is located at the extreme northern part of the works, and extends from a point at about Third street to the river front. It is the largest and most important of its kind on the Pacific system.

"All cars requiring heavy repairs or rebuilding are sent here, where they undergo a thorough inspection, and, if it be found advisable, are again placed in serviceable condition. If, on the other hand, they be found unfit for further service, owing to age and decay, or from being in a badly damaged condition, the car is torn to pieces, the trucks laid aside for future use on another car, the ironwork assorted and the woodwork otherwise disposed of, usually being used for fuel.

"In this shop are repaired and rebuilt about 700 cars monthly, or 8,400 during the year. The amount of material used monthly is estimated at about 60 carloads, which includes lumber for the floors, roofs and sheathing, timber for the sills and bolsters, and the ironwork used in the construction and repair of cars.

"Many of the cars turned out are painted all over, and in such cases the old tedious process of brush work is relegated to a back seat, and the labor performed by means of an air machine. A vessel, not unlike an ordinary sprinkling can in appearance, though considerably smaller, is so arranged that the air, which is procured from pipes distributed throughout the shops by a system of pipes, is forced under heavy pressure into an opening in the nozzle of the paint tank, which has been filled with paint, thereby forming a vacuum and drawing out the paint through a small valve with great force, so that it reaches the car in the form of a fine spray, penetrating the wood, thus turning out a clear, even and satisfactory piece of work.

"Some idea can be realized of the rapidity by which this little 'pneumatic gun' does its duties, when a flat-car can be given a coat in about five minutes and a box-car in 25 minutes, when handled by one who understands how to manipulate it. The car is then numbered, lettered and stenciled, and is again ready for the road.

"Almost all work done at this shop is conducted under the 'piece rate system,' which has proven to be entirely satisfactory both with the employees and the company, as the rates are always fixed so that the mechanic need do but a fair day's work for a correspondingly fair day's pay.

"As previously stated, a large amount of work is done at this shop, as everyone will understand, when it is considered that each month about 650 sills and 500 draft timbers are used, 120 floors laid, 70 roofs and about 350 California couplers applied.

During the month just passed, 31 carloads of 'scrap' were taken from the repair shop.

"This department is under the direction of C. A. Phipps, and he is ably assisted by his corps of under-foremen, and over the entire car-repair plant is Master Car Builher Benjamin Welch, upon whom the mechanics and laborers, in the fullness of their admiration, love and respect, have conferred the title 'Uncle Ben.' "

Annual Convention of the Master Car and Locomotive Painters' Association.

The twenty-seventh annual meeting of the Master Car and Locomotive Painters' Association will be held in New York City on the 9th, 10th and 11th days of September, 1896, convening at 10 o'clock A. M. on Wednesday, the 9th, at the Park (Fourth) Avenue Hotel, which has been chosen as the official headquarters of the association. The local committee of arrangements has secured a special rate of $3 per day, American plan, and those who expect to attend the convention are requested to engage rooms at an early day, stating length of time the room is wanted, and to avoid any disappointment, those engaging rooms should request the proprietors, Wm. H. Earle & Son, to send them the number and location of room.

The list of subjects to be considered is as follows:

1. The application of compressed air in burning off cars.
2. The cause and prevention of the flatting of varnish on coaches and engines.
3. Is it advisable to paint locomotive jackets, either planished iron or black steel? If so, which is the best and most economical method?
4. Essay "Painting Galvanized Iron."
5. Can a coach be painted to meet the necessary requirements with four coats of paint, or as otherwise termed, the enamel process and retain the same general appearance and durability as when painted under heretofore prevailing methods?
6. The practical painting of a locomotive.
7. Essay. Is it good policy to house passenger cars at terminals? If so, can our companies afford it?
8. Which is the best method of painting superheated parts of locomotives, viz., dome casings, cylinders, steam chests and extension fronts?
9. Which is the most economical and durable, a sandpaper or a pumice stone surfacer?
10. Spontaneous combustion in the railway paint shop. Its cause and prevention.
11. Report from Committee on Tests.

The Mileage of Chilled Cast-Iron Wheels in Freight Service.

The great improvements made in chilled iron car wheels in recent years is, in a manner, exemplified in their increased mileage. Notwithstanding the greater weights carried on them the mileage is much greater now than it was 10 or 15 years ago, and there is a good prospect that the first-class wheels put into service at the present time will maintain, if they do not add, to the reputation of such wheels.

To those who have not followed the mileage records closely there is much of interest in the following statement showing the service of chilled iron freight-car wheels on the Chicago, Milwaukee & St. Paul Railway, and kindly furnished by Mr. J. N. Barr, Superintendent of Motive Power:

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY.
Office Superintendent Motive Power.
Statement showing service of freight-car wheels.

Calendar year.	No. of freight wheels m'de or bought.	Freight car mileage.	Number of freight cars.	Number of freig't whe'ls in service.	Average mileage.	Average life of wheels.		
						Years.	Mon's.	Days.
1885	22,395	215,459,302	19,402	155,216	76,968	6	11	15
1886	19,459	236,140,419	21,385	171,080	97,080	8	9	15
1887	21,721	250,774,965	21,678	173,424	81,152	7	0	1
1888	21,162	261,100,022	22,544	180,352	86,544	7	5	17
1889	26,015	250,990,286	22,776	182,208	77,184	7	0	1
1890	15,823	263,983,845	23,864	190,912	133,468	12	0	21
1891	12,810	305,482,841	25,674	205,392	190,776	16	0	12
1892	17,340	334,943,674	26,308	210,372	151,528	12	1	18
1893	17,332	312,503,212	27,963	223,612	141,240	12	10	24
1894	11,647	276,300,355	27,800	222,400	189,784	19	1	4
1895	14,219	289,316 350	27,687	221,408	162,776	15	6	26

The column headed "average mileage" is obtained by dividing the total car mileage on the road during the year by the number of wheels removed. For instance, if 10,000 wheels are in service, and 1,000 are removed each year, the average length of service would be 10 years, and the average mileage would be 10 times the yearly mileage of the cars. This, of course, does not give accurate results for any particular year, but does give a definite and correct comparison when extending over a period of years, so that the figures really show the average mileage of all wheels removed for any cause whatever.

It will be noticed that in the last six years the average mileage of the wheels removed fluctuates from over 133,000 to more than 190,000, while in previous years it never reached 100,000 miles. Another striking feature of the table is the sudden rise in average mileage between the years 1889 and 1890. This we are not able to explain fully, but it might be stated as in part explaining the sudden rise and the higher average mileage after 1890 than before that date that since the date mentioned a very large percentage of the wheels in service were cast in contracting chills. But whatever may be the cause or causes which have operated to increase the average mileage of cast-iron wheels, the result is most gratifying and is not confined to any one road. The figures speak well for the continued use of such wheels under the constantly-increasing freight loads.

It doubtless will be a surprise to many to know that the average life of a good cast-iron wheel in freight service is more than 15 years and that some of them even run for 20 years. Yet such is the fact and more than one road can testify to it. In a discussion at the recent M. C. B. convention one member mentioned this long life of cast-iron wheels, and doubtless others could furnish additional evidence of their durability.

The Introduction of Our Engineering Practice in the South American Republics.

In the last ten or fifteen years several spasmodic attempts have been made by American manufacturers to build up a foreign trade in their products, and signs are not wanting at present of a greater, more widespread, and (what is of greater significance) a decidedly more systematic effort that is being exerted in this direction. The organization of a national association of manufacturers, one of whose objects is to further the foreign trade in American manufactures, and the visit of a committee of its leading members to South America to look over the field there, are indications of the interest which manufacturers in this country are taking in foreign markets.

Another important project and one that should command the attention of manufacturers of all kinds of railway supplies, machinery, machine tools and materials for the construction of roads, docks, bridges, buildings, etc., is that which the well-known firm of Flint, Eddy & Company, of New York, are now undertaking. This firm has been engaged for years in the introduction of constructive materials made in the United States into the other countries on the American Continent, and some of the largest orders placed in this country by South American parties have been given through their agency and largely as a result of their well-directed efforts. Believing that the time has come when a larger part of the trade with these countries can be obtained by reliable firms in the United States, they are preparing to represent a greater number of manufacturers and builders of all kinds of machinery and engineering supplies, and expect to place in the hands of possible purchasers an amount of information about machinery and materials obtainable here, that will facilitate and increase the business with this country.

One of the methods to be employed in presenting this information to foreign purchasers is the publication of a book of information, copies of which will be distributed among mechanical and civil engineers in responsible positions, managers of important enterprises and others who are or may soon become purchasers of machinery or material. This valuable work is now being compiled and will contain fully one thousand pages about 9 inches by 12 inches in size. The reading matter on each page will be arranged in three columns, one in Spanish, one in Portuguese and the other in English. The scope of the work can be judged from the general divisions under which the information is grouped, which are as follows: Railroads, Lake and River Navigation, Public Works, Electrical Appliances, Special Industries (which will principally comprise ice-making machinery and sugar-making machinery). These general divisions are sub-divided until they include in systematic arrangement everything needed in the construction, operation and maintenance of works, structures or industries suggested in the general divisions of the book.

The information given in each case will, as far as possible, consist in specifications of materials, descriptions and illustrations of machinery, advantages of same, prices, weights assembled, weights as packed for shipment, etc., all weights and measurements given in both the English and metric systems, and the whole so arranged as to give the reader an accurate knowledge of what is obtainable in the markets of the United States, as well as furnishing him an outline of the best practice in this country. A person consulting the book will thus be able in many cases to place his order without a disheartening amount of correspondence and cabling for information, with its attendant delay and expense. As the book illustrates and describes only the best, it will also be a testimonial to the excellence of American manufactures, and being printed in a language the intending purchaser can understand, should help him wonderfully and should open the way for a profitable and satisfactory business.

The compilation of this book is in charge of Mr. Emilio Del Monte, a civil engineer, who has spent much time in Cuba and South America and is thoroughly conversant with the requirements of those for whom the book is intended, and when it is published he will go to those countries, and possibly to South Africa also, in the interests of Messrs. Flint, Eddy & Company.

That such a reliable and well-informed firm should be making such extensive preparations for an enlarged business with foreign countries certainly speaks well for the prospects of American manufacturers in those markets. Familiar as they are with all the conditions of trade in those countries, they would hardly engage in such an enterprise without every reasonable assurance of ultimate success. To those who are desirous of finding a market in the countries mentioned there is thus afforded an excellent opportunity. The firm in the course of its successful career has attained a high standard in the opinions of those with whom it has done business, and its knowledge of business methods in the countries into whose markets it enters American goods are both factors that point toward success in the present undertaking.

They manifestly need the hearty co-operation of American manufacturers and builders, and we think this will certainly be given them. Our manufacturers not only need other markets than those at home, but they realize keenly as the result of industrial events in this country during the last three years that a foreign trade of considerable dimensions will help them to keep their business going with more regularity and profit than where they are dependent on the home market alone. Skilled labor and inventive genius have done so much for American industries that the result of a competition with other nations in foreign markets cannot be otherwise than successful. Messrs. Flint, Eddy & Company have offices at 66 and 68 Broad street, New York City, and will cheerfully give information to those desiring it.

It is proposed to establish iron and steel works in Japan, and the Imperial Diet has approved of an appropriation of about a million sterling for that purpose. The estimated output of the works, which are likely to be in full working order in about three years' time, is 60,000 tons per annum; which total is to be gradually increased as the works develop. The product is to be divided into 35,000 tons of Bessemer, 20,000 tons of Siemens-Martin, 4,500 tons of wrought iron, and 500 tons of crucible steel. This enterprise is being undertaken with great deliberation, and there can be little doubt of its complete success. In the near future it is probable that Japan will not only be able to supply its own wants for iron and steel, but may have a superfluity that can be shipped to other countries.—*Industries.*

The Association of Superintendents of Bridges and Buildings will hold their annual convention in Chicago, on October 20, 21 and 22, and have made arrangements with the Leland Hotel, corner of Jackson street and Michigan avenue, for the accommodation of the members.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.

BY OSCAR ANTZ.

(*Continued from page 105.*)

FREIGHT TRUCKS.

One of the principal points in which American-built cars differ from those of other countries is in the manner of supporting the car-bodies on the wheels. On foreign cars the journal boxes on the axles usually work in pedestals or other contrivances attached rigidly to the car-body, thereby always keeping the centers of the axles at right angles with the center line of the car; the lost motion in the bearings and boxes and the sideplay of the wheels on the track are depended upon to allow the car to move around curves. On American-built cars the body is generally carried on two independent trucks, each of which is supported by two pairs of wheels and axles; the body is not rigidly connected to the rucks, but merely rests on them at their centers, leaving them free to adjust themselves to suit variations in the surface and line of the track.

The trucks are without doubt the most important part of a car when its safe running on the track is considered, and as certain parts of them are subjected to considerable wear, even in ordinary service, it is of the utmost importance to have these parts made so that they can be readily replaced whether on the home road or on foreign lines. This fact was recognized early in the existence of the M. C. B. Association and standards were prescribed for these parts, which have been adhered to more closely, perhaps, than any of the other M. C. B. standards.

WHEELS AND AXLES.

Naturally the wheels and axles received considerable attention. While it would hardly be policy to recommend an absolute standard for a wheel, still the diameter of 33 inches is now almost all over this country recognized as the proper size of a freight-car wheel; the shape of the tread or part which rests on the rail, the thickness and shape of the flange, as well as the location of the wheels when mounted on the axle, have been adopted as standards.

Freight-car wheels are usually made of cast iron of the so-called double-plate type, with a chilled tread, and specifications have been drawn up for these, which are recommended by the M. C. B. Association as good practice, as they are based on the results of many experiments and deductions obtained from practice. The usual weight of a cast wheel for cars of 60,000 pounds capacity is about 600 pounds. Wheels of other material than cast iron are used somewhat, but to no large extent in freight service—these wheels generally being provided with independent tires of steel.

Two sizes of axles have been adopted, one for cars of 40,000 to 50,000 pounds capacity, and one for those of 60,000 pounds. The length between centers of journals is the same in both, viz., 6 feet 3 inches; the size of the journal of the smaller one is $3\frac{3}{4}$ inches diameter and 7 inches long, that of the larger one $4\frac{1}{4}$ inches diameter and 8 inches long, the other parts of the axles being in proportion. The weights are about 400 pounds for the smaller one and 500 pounds for the larger.

Attempts have been made in recent years to increase the size of of the smaller journal to 4 inches in diameter, but this change has not been officially adopted.

The sizes of an axle and other parts of the running gear for cars of 80,000 pounds capacity are at present under consideration by the association.

Axles are made of both wrought iron and steel and each metal has numerous advocates, and it would be presumptuous to say that either is the better metal. Steel of a good quality is perhaps the stronger and is less liable to have inherent defects in the shape of hard spots, seams, etc., but it is the experience of many roads that steel axles are more liable to heat and occasionally break without apparent cause.

JOURNAL BOX AND CONTAINED PARTS.

The journal box and contained parts, viz., journal bearing and key, for both sizes of journal, and also the general outline of a journal box-lid which answers for both sizes of box, have been adopted as standards; as all of these parts, as well as the wheels and axles are published each year in the Proceedings of the M. C. B. Association, they will not be reproduced here.

RIGID TRUCKS.

The distinctive American truck is the diamond truck, so-called from the shape of the framework connecting the two journal boxes on the corresponding ends of the two axles of the truck. There are two of these frames connected together by a crossframe which supports the bolster on which the car-body rests. The bolster rests on top of springs which are either supported directly by the crossframe, thereby allowing no lateral motion of the bolster with respect to the truck frame, or else the springs rest on

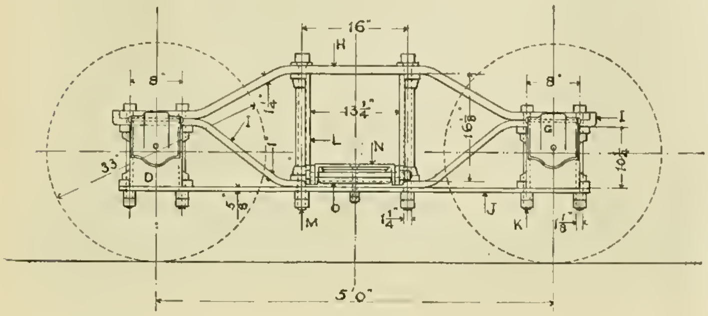


Fig. 39.

a platform which is suspended by hangers from the crossframe. and allows a certain amount of lateral motion of the bolster, This difference gives us two distinct styles of trucks, the so-called rigid and the swing-motion.

Rigid trucks are now almost universally used under heavy cars in this country, as their construction is stronger and their first cost and maintenance are less than with the swing motion style; a large part of the lighter cars also use this style of truck, of a lighter construction. Trucks of other than the diamond style have been under freight cars, and since the introduction of pressed steel in car construction several new types have been put on the market, which will be considered later.

Figs. 39, 40 and 41 represent a rigid diamond truck, which can be considered as a good example of modern practice, the bolsters and springs being omitted, as these will be shown by themselves.

The wheels *AA* are mounted by means of hydraulic pressure on the axles *BB*, the journals on the ends of these run in journal bearings *CC*, which are held in the journal boxes *DD* by the keys *EE*. The journal is lubricated by oil or grease held in suspension by wool or cotton waste, with which the lower part of the journal box is filled; wooden dust guards *FF*, which are inserted in a slot in the back of the box, and covers *GG* on the front prevent dust

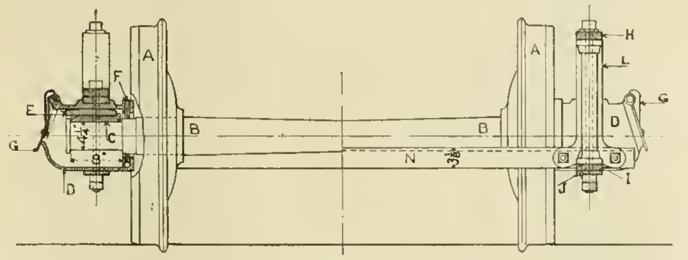


Fig. 41.

rising from the roadbed from entering the box and causing the journals to heat.

Connecting the journal boxes on each side of the truck are the archbars *HH*, the inverted archbars *II* and the tie bars *JJ*, all of which are secured to each box by two 1⅛-inch journal box bolts *KK*. These bolts, as well as all the other bolts of the truck, should be provided with double nuts or some other means of securing the nuts against working off the bolts, which they are very liable to do on account of the constant jar. The inverted archbar is turned up at its ends, forming lugs against which the upper archbar is fitted. Archbars vary more or less in cross-section, and attempts to have them standardized by the Master Car Builders' Association have not been successful. The width of 4 inches is generally adopted for 60,000-pound cars, but the thicknesses vary; those shown can be considered good practice. The wheel base or distance between centers of axles is generally 5 feet or 5 feet 2 inches.

To obtain trucks of various heights from rail to center-plate, with as few changes as possible, such as would be desirable for the sake of adhering as nearly as possible to one standard, on a road having cars which vary in the vertical distance from center-plate to drawbar center, the offset of the archbars can be varied to suit these heights, the total distance at the center being always the same; and this can be done without making any other changes whatever. This is done to quite some extent in practice, there being cases in which the upper arch-bar is made entirely straight, and others where the tie-bar is arched up at the center.

Separating the upper and the inverted arch-bars near their centers are the two column guides *LL* which are secured to the arch-bars by the 1¼-inch column bolts *MM*, and to the spring plank by two ¾-inch bolts passing through both columns and through the spring plank. Column bolts should be made with a fillet under the head, and to avoid counterboring the arch-bar for this fillet, which would weaken the bar, a thin malleable washer can be placed under the head with the space for the fillet cast in it. The column guides preserve the distance between the arch-bars and also act as guides for the truck bolster, and prevent it from moving laterally, leaving it free to move vertically.

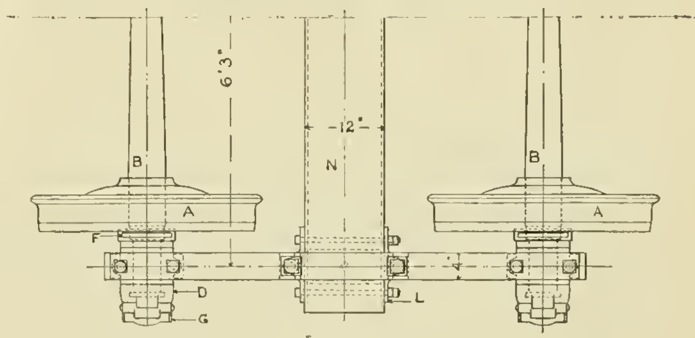
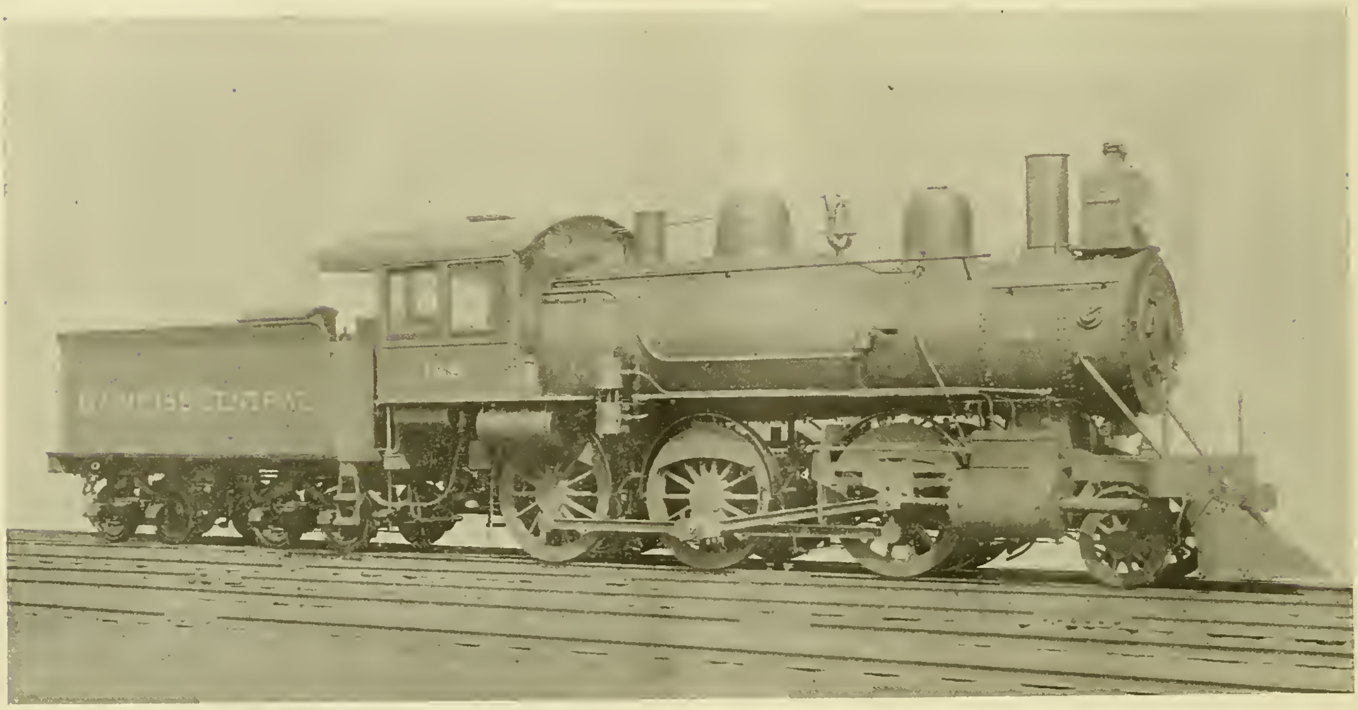


Fig. 40.

The spring plank *NN* connects the arch bars of the two sides of the truck and is bolted to the column guides by the two ¾ inch bolts mentioned and also to the lower arch and tie bars by one ¾ inch bolt, a casting *OO* being introduced to fill up the space between the flanges when a channel bar is used with the flanges turned down. The spring plank acts as the support for the bolster springs, and in the earlier cars was made of wood, hence its name. Spring planks are now usually made of channel bars, the one shown being 12 inches wide. There is no common custom in placing the bars, in regard to having the flanges up or down, both methods being practiced, and there is probably very little difference in the end. Spring planks have recently been made of pressed steel of the general shape of the channel bar.

The weight of the metal in the trucks of an ordinary freight car is far in excess of the weight of all the balance of the metal in the car, and attempts have been made of late to reduce this weight to some extent. This is accomplished by making the castings of malleable iron, instead of cast iron, whereby they can be lightened up probably one-half, and as the cost of malleable iron is about twice that of cast iron, the cost of the car is not materially increased. Pressed steel is also used somewhat for certain parts, whereby they can be lightened even more yet.

In the rotating tests of cylindrical shafts conducted at the Watertown Arsenal it is said that all steels as yet experimented with have failed under a fiber stress not exceeding 40,000 pounds per square inch, with a total number of repetitions of from four to seven millions for high steels.



Mogul Freight Locomotive With 20 by 26-Inch Cylinders—Maine Central Railroad.

Built by the Schenectady Locomotive Works.

Mogul Freight Locomotive for the Maine Central Railroad.

We are indebted to the Schenectady Locomotive Works for the photograph from which was made the accompanying engraving of one of the mogul engines recently built by the firm for the Maine Central Railroad. There were five of these engines in the order, and they were built to conform to specifications furnished by Mr. Amos Pillsbury, Superintendent of Motive Power of the road. The boiler is of the extended wagon-top type, and carries 190 pounds pressure. It has a large grate and ample heating surface, and is proving to be an excellent steamer. The engine has the full deck common to the ordinary eight-wheeled engine, thus securing a convenient arrangement of levers and valves in the cab—a matter which the men appreciate. The pistons have their rods extended through the front cylinder heads, a practice that is gaining in favor, as it is found that the saving in wear in the cylinders of large engines is considerable. The engines have 63 inch driving wheels, and 20 by 26-inch cylinders, proportions which will make a satisfactory and economical freight engine. The use of comparatively large drivers on freight engines is a move in the right direction.

From the specifications we take the following particulars:

General Dimensions.

Gage	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order	136,600 pounds
" on drivers	117,600 pounds
Wheel base, driving	14 feet 6 inches
" " rigid	14 feet 6 inches
" " Total	22 feet 3 inches

Cylinders.

Diam. of cylinders	20 inches
Stroke of piston	26 inches
Diam. of piston rod	3¼ inches
Kind " " packing	Dunbar
" " " rod packing	U. S. Metallic
Size of steam ports	18 inches by 1¼ inches
" " exhaust "	18 inches by 3 inches
" " bridges "	1¼ inches

Valves.

Kind of slide valves	Richardson balanced
Greatest travel of slide valves	5½ inches
Outside lap " " "	¾ inches
Inside " " " "	$\frac{1}{32}$ inch
Lead of valves in full gear	$\frac{1}{16}$ inch
Kind of valve stem packing	U. S. Metallic

Wheels, Etc.

Diameter of driving wheels outside of tire	63 inches
Driving box material	Steeled cast iron
Diameter and length of driving journals	8½ inches diameter by 11 inches
" " " main crank pin journals	6 inches diameter by 6 inches
" " " side rod crank pin journals	Main 6½ inches diameter by 5¼ inches F. & B. 4½ inches diameter by 3¾ inches.
Engine truck, kind	Two-wheel, swing bolster
" " journals	6 inches diameter by 10 inches
Diameter of engine truck wheels	33 "
Kind " " " "	Krupp No. 3 wheel. Tire 3⅛ inches by 5½ inches, held by retaining rings.

Boiler.

Style	Extended wagon top
Outside diameter of first ring	62⅛ inches
Working pressure	190 pounds
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	½ inch, $\frac{9}{16}$ inch, ⅝ inch, $\frac{11}{16}$ inch and $\frac{7}{16}$ inch
Horizontal seams	Butt-joint, sextuple riveted, with welt strip inside and outside.
Circumferential seams	Double riveted
Firebox, length	96$\frac{3}{16}$ inches
" width	40⅜ "
Firebox, material	Carbon steel
" plates, thickness,	Sides, $\frac{5}{16}$ inch; back, $\frac{5}{16}$ inch; crown, ⅜ inch; tube sheet, ½ inch
" water space	Front, 4 inches; sides, 3½ inches; back, 4 inches
" crown staying	Radial stays, 1 inch diameter
" staybolts	Taylor iron, ⅞ inch and 1 " "
Tubes, material	Charcoal iron, No. 12 W. G.
" number of	320
" diameter	2 inches
" length over tube sheets	12 feet
Fire brick, supported on	Water tubes
Heating surface, tubes	1,996.64 square feet
" " water tubes	20.51 " "
" " firebox	155.03 " "
" " Total	2,172.18 " "
Grate "	25.96 " "
" style	Rocking, with dump plates
Boiler supplied by	Two Hancock inspirators, Type D., No. 9

Tender.

Weight, empty	37,800 pounds
Wheels, number of	8
" diameter	33 inches
Journals, diameter and length	4½ inches diameter by 8 inches
Wheel base	14 feet 6 inches
Tender frame	6½ inches by 4 inches by ¾ inch angle iron
" trucks	4-wheel, channel iron, M. C. style
Water capacity	4,000 U. S. gallons
Coal "	8 (2,000 pounds) tons
Total wheel base of engine and tender	47 feet 7½ inches
" length " " " "	56 feet 5⅜ inches

The engines are fitted with the Westinghouse-American brake on all drivers, tender and for train, two 3-inch Ashton safety valves—one muffled and one open pop, Asbestos cement boiler lagging, Trojan coupler on pilot and rear of tender, National Hollow Brake Beams, with Lappin flanged shoes, and No. 3 Crosby 6 inch Chime whistle.

The engines have been in service long enough to demonstrate that their operation is excellent and that they are very light on fuel.

Transmission and Application of Power to Machine Tools.*

The years 1866 to 1873 saw a large number of stationary riveters successfully introduced, and the success of the hydraulic system firmly established. Flanging and stamping presses and hydraulic shears were also introduced in considerable numbers during this period. In 1871 the portable riveter was designed and patented by the author. The manufacture of this entirely novel type of machine tool was, however, declined by several engineers, including those who had been so successful with his stationary machines, as visionary and impracticable. The author was at last fortunate enough to secure the co-operation of Mr. James Platt, a Lancashire engineer, established at Gloucester in partnership with Mr. Fielding. They undertook to make it. It is quite certain, however, that neither the author nor Mr. Platt had any idea of the troubles in store for them. The difficulties were not so much due to its special hydraulic features as to the difficulty at that time in obtaining suitable steel for the arms, getting sufficient rigidity, combined with lightness, and arranging all the various connections to lead the water from the accumulator to the porrtable riveters suspended many feet in mid-air. However, in 1873, the Primrose Street Bridge, over the Great Eastern Railway, London, was completed, being the first bridge mechanically riveted in *situ*. Just as most of the initial difficulties were surmounted Mr. Fielding died, and in the many new designs and applications introduced and patented since then, his son, Mr. John Fielding, has been closely identified.

But if 1873 was an important epoch in hydraulic riveting, the year 1878 afforded the first opportunity of fully showing the economical advantage of the hydraulic system as a means of transmitting power to machines of many different kinds spread out over great distances. In consequence of the author's representation, and the assistance of his colleague, Mr. Henry Chapman, of Paris, Mons. Marc Berrier-Fontaine, the engineer of the French arsenal at Toulon, authorized the laying out of the whole of their new works on the author's hydraulic system; the machinery being supplied by the Hydraulic Engineering Company, of Chester, and Messrs. Fielding & Platt, of Gloucester, and from that time the hydraulic system of machine tools was firmly established, and occupies in its proper field an unassailable position by reason of its economy and convenience of application.

There were two causes some 25 or 30 years ago which assisted the introduction of the hydraulic system for special classes of machine tools—first, the increasing size and scantling of all boilers, bridge and ship work, and second, the increased areas thereby covered by the works themselves. So long as hydraulic power is confined to work of a more or less reciprocating character (with the one exception of capstans), there is no other system comparable with it on the score of economy, but when we come to driving lathes, planers, spread over large areas, electrical power comes in on the ground of the convenient way in which it can be transmitted over great distances, and the suitability of its motors for rotary work. Always bearing in mind that their suitability for the work to be done is ascertained, it may be stated that for transmitting and applying power over great distances, water and electricity have both their special advantages. Electric transmission, if more costly, is on the other hand very conveniently applied at different points; traveling cranes may be cited as one of the best applications.

So far as the relative economy of hydraulic power, shafts and belting or electricity are comparable, it is easier to compare shafting with electricity than either of these with hydraulic power. In the case of the former, given an equally economical and efficient prime mover, for all reasonable distances, it resolves itself into a question of the interest on cost of shafting only, or on that of dynamo, with its leads, motors and shafting. When the distances become greater we can then compare the relative cost and advantages of hydraulic and electrical transmission. In many cases even this comparison is not possible, for the operation to be performed by the hydraulic machines and those driven by electricity are in many cases essentially different. Many of the heaviest operations done by hydraulic tools only occupy so short a time that a large reserve of power must be stored up to render them practicable. For reasons of cost this is not possible with electricity, but in the hydraulic system, perhaps, the most important feature is the accumulator, and it constitutes the most important factor in its economical success. We may at once eliminate this feature in an electric system on account of its present great cost, and, of course, in transmitting power by shafting or ropes it is also impossible; and it can only be adopted to a limited extent in pneumatic transmission.

In the case of transmission by shafting or electricity, the prime mover must be large enough to meet such demands when they occur, but in the hydraulic system, not only is the prime mover not required to be equal to the greatest efforts (only occasionally required), but on the other hand the size of the prime mover can be very much reduced; for the accumulator allows of the smaller engine being kept more or less continuously running and storing up power during the very considerable intervals when only a portion of the machines are at work.

This question of the proportion of machines absolutely engaged "tooling" and those standing idle while work is being taken to or from them, or from other causes, is not a new one. The author alluded to this in a paper read by him in 1886, and gave some figures based on data published by Mr. William Hartnell. It may not be amiss to draw attention to the very considerable mechanical, if only occasional, work done in hydraulic machine tools with prime movers of almost pigmy proportions. In our youthful days the raising of the Conway Bridge tubes was always cited as an instance of a great effort. Well, the best they did was lifting 1,300 tons 13 feet in 60 minutes, or 282 foot-tons per minute. The ordinary 150 tons riveting machine will make four strokes per minute of 6-inch each = 300 foot-tons per minute, but the mechanical effort is really more, for these two feet are really done in little over 20 seconds, the remaining 40 seconds being required for the return stroke of the ram. If such a machine had to be driven by shafting or electricity, in the first instance the prime mover must be equal to exerting this 300 tons in 20 seconds plus friction of shifting; and in the case of electric transmission the prime mover must be the same plus the losses incidental to the dynamo, the cables and the electric motor gearing between it and the machine. We will leave it to others to minimize or fix these losses, but we know that in the case of pumps and accumulators and mains, which we may take as occupying the same place as the dyamo, leads and electric motor, that the loss is extremely small.

The efficiency of good pumps is 78 per cent., that of the accumulator 91 per cent., and the loss in properly designed mains is extremely small.

Coming now to the machine tools to be worked by the water thus transmitted: It is, of course, understood that generally speaking we are only discussing, this evening, machines suitable for hydraulic pressure, either by reason of their being required to exert a great force during a short period, or to exert in addition more numerous efforts (such as punching, shearing or riveting) at distances from the prime mover beyond the reach of shafting.

In the former case we have shown that the hydraulic system alone meets the ease, and for great efforts, such as forging, flanging, etc., the same applies. But in smaller machines there is more room for divergent opinions.

This brings us to the consideration of the suitability of hydraulic pressure for punching and similar machinery, placed about large ship and bridge yards. We have lately seen some startling instances, from an electrical standpoint, of the wastefulness of this class of machine driven by separate steam engines, all of which was pointed out by the author 24 years ago, in many technical journals and papers, with the view of substituting hydraulic machines.

Electricity as a motive power for moderate sized machines in frequent work certainly seems to fulfil most of the conditions, but it cannot claim to have all its own way. The machine has to wait till the speed of the motor is got up, and a similar loss of time and power ensues when the machine is being stopped, whereas in the hydraulic machine it is only consuming power while work is being done. There are, of course, losses peculiar to the hydraulic system, and there are climatic considerations to be considered, and the final verdict as to the power selected can only be the result of experience and judgment brought to bear on each particular case.

In many classes of work it is essential that the exact pressure exerted be known, and that the same pressure be exerted every time it is applied under similar conditions. This is the case more especially in riveting. In the case of riveting, as is well known, the length of rivets, when finally closed, is more or less a varying one, owing to the temperature, number of thicknesses of plates, etc. The hydraulic ram can be made of sufficient stroke to do the shortest or the longest, and at the end in every case exert the same final pressure. We have in this a very important advantage—only obtainable in hydraulic machines. This range of travel is one of the chief advantages of all hydraulic machines, and is practically unobtainable in geared machines, whether driven by shafting or electric motors.

* Part of a paper written by the late M. R. H. Tweddell and read January 25, 1896, before the Manchester Association of Engineers.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING.......................................NEW YORK.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

SEPTEMBER, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

The notification by the Postmaster-General that the law would be enforced forbidding the transportation of letters or other written papers on railroad trains unless postage is paid on them, was a knockout-out blow at the "R. R. B." letters. The action of the railroads under the notification has not been uniform. Some have abandoned "R. R. B." mail entirely, while a number of large companies have issued orders that the correspondence sent by "R. R. B." mail shall only be such as pertains to the business of the company and destined to points on its road. In other words they hold by this action that the exchange of railway mail between railroads may be rightfully stopped by the postal authorities, but that their right to transport their own letters in their own cars to points on their own line cannot be taken from them, the law to the contrary notwithstanding. The law as it stands appears to be with the Postmaster-General, but if pressed far enough it is believed that it would be declared unconstitutional, in-so-far as it prevents railways carrying their own mail between points on their own lines.

The use of compressed air in railroad shops, which has made such progress of late, did not originate in recent years. We are informed that in 1879 the first air motor to be used in the Missouri Pacific shops was made and put in operation in the St. Louis shops of that road. It is claimed that this was the first railroad shop to use compressed air in running small tools and doing other work which otherwise had been done by belt-driven machinery. As early as December, 1882, there appeared in the NATIONAL CAR BUILDER, an article on these shops in which the following reference was made to the use of compressed air: "These shops have in use a portable drilling machine driven by a three-cylinder Brotherhood engine supplied with air from two Westinghouse pumps. These engines are quite small, are mounted on wheels, and are also used for driving staybolt taps, portable cylinder-boring machine and valve-facing machine. They were designed by Mr. Hewitt, the superintendent of machinery, aided by his assistant, Mr. Leroy Bartlett. Inasmuch as they can be taken to any place in the shop and applied to almost any kind of work, taking the place of handwork in many cases, it is a little surprising that such machines are not more generally used." Thus, as far back as 1882, we find the advantages of compressed air clearly stated and the practice of one road cited in a way that shows its officials had applied it to many of the uses to which it is now put. Why others should have been so slow to take it up is not clear, but whatever the reason the rate at which it has been adopted in the last few years shows that at present it is appreciated.

A contemporary publishes in a recent issue a description of an air compressor being built at Bridgeport by a company whose object seems to be much the same as that in view by the free silverites in the present political campaign—they want to get something for nothing. They are persuading themselves that a 140 horse-power steam engine will turn an 82-foot wheel and develop 2,500 horse-power at the rim. The 82-foot wheel carries ten groups of wheels, three in a group, each wheel weighing 4½ tons. These wheels, as the large one revolves, operate cam levers connected with the pistons of 100 compound air compressors with 16-inch by 12-inch intake cylinders, secured to a fixed circular track under the wheel. The mechanism thus consists of 204 pistons, one 82-foot wheel, thirty 9-foot wheels, 50 cam levers, numerous gears, etc., etc., while eight single compound compressors with 32-inch by 36-inch cylinders would compress a like amount of air. But this extra mechanism is as nothing compared with the power to be *created* by it, which is 2,500 — 140 = 2,360 horse power, which, if worth $30 per year per horse-power, amounts to $70,800 per annum. This, you see, is clear gain. But why don't the promoters dispense with the machinery and use the 140 horse-power engine alone? All they need do is pronounce its output to be 2,500 horse power instead of 140 horse power, and then rake in the $70,800 per year. That is what we are asked to do with the silver dollar—just announce that its 53 cents are not 53 cents but exactly 100 cents, and lo! it will be so. The simplicity of such a proceeding makes it far superior to using hundreds of tons of machinery to raise 140 horse-power to 2,500 horse-power.

The illness of two of the engineer officers of the United States battleship *Indiana*, Chief Engineer George E. Tower and Passed Assistant Engineer A. McAllister, during the manœuvers of the Atlantic squadron last month, is a forceful illustration of the need of an increase in the engineering branch of the navy. The modern battleship is an immense aggregation of machinery—machinery everywhere and for everything, and that the large amount of skilled labor and of mental energy necessary to keep it in good condition at all times, is not realized or is deliberately ignored and the lives of officers thereby jeopardized, is a disgrace. The cruiser *Columbia*, with 90 engines, 172 steam cylinders, and all its varied and complicated machinery, has only four engineers. Is it any wonder the engineers are unable to stand the strain? There are to-day four line officers to one engineer in the navy, and yet the line officers are actively opposing any increase in numbers or authority of the engineers. And so after eight days of peaceful manœuvering the efficiency of the most powerful battleship of the navy is for the time impaired by the temporary loss of one-half of its engineering staff. What would be the condition of affairs in case of war if peace manœuvers are so disastrous? Who is going to assume the responsibility for this condition of affairs? It is to be feared that when the citizens of this nation finally awaken to a realization of what is going on they will refuse to believe that anything approaching patriotism and the good of the service has been the actuating motive of line officers, and these officials will then lose more of their prestige than if they now used their influence to promote needed reforms. The more the pendulum is held to one side of the normal the further it will go to the other side when once it is liberated.

The economy in the direct application of the power of a steam engine to the work to be done is generally conceded, and the magnitude of the saving thereby effected is well illustrated by the power required for driving the "jack shafts," so common in electric installations a few years ago. In the power station of the Elmira Illuminating Company, of Elmira, New York, there is a jack shaft 136 feet long by $5\frac{5}{16}$ and $6\frac{5}{16}$ inches in diameter. To this shaft are belted five steam engines, three of which are of 300 horse power each, and one of 500 horse power, and a number of dynamos, the shaft having 20-clutch couplings, so as to use any desired combination of engines and dynamos. The horse power required to drive this shaft was 83.2, and in a recent test of the 500 horse-power engine recorded in a paper before the American Society of Mechanical Engineers, the percentage of the total engine power consumed by this shaft varied from 16.6 per cent. under a full engine load to from 30 to 45 per cent. under the light loads. This indicates one of the advantages obtained in the direct connected engines and dynamos now almost universally installed in such stations, and is also suggestive of the economies which can be obtained by a judicious rearrangement of line shafting in shops, by which much of it will be dispensed with and the tools driven singly or in groups by electric motors.

A contemporary in giving the general results of the tests which a certain railroad is making with the simple and compound mogul engines built at its shops, states correctly that the various kinds of compounds do not differ much from each other in economy, and average about 15 per cent. less coal than the simple moguls. It then makes the statement that these compounds compared with a class of consolidations pull 15 per cent. more load and do the work on less than half the fuel. This is one of those sweeping statements that won't bear investigation. To illustrate: If we take "less than half the fuel" at 45 per cent. and do 15 per cent. more work with it, the result is the same as if the same amount of work had been done with 39 per cent. of the fuel used by the consolidation engines. Now, either the compounds are marvels, the consolidations of shockingly bad design, or the statement of performance untrue. The probability is that the trouble is with the statement. A large saving ought to be expected from three causes—the compounding, the use of relatively large drivers and the elimination of one pair of drivers, but as the compounding is only credited with 15 per cent., railroad men will be slow to believe that 46 per cent. saving is obtainable by using a mogul with 62-inch drivers in place of a consolidation engine with much smaller wheels. And yet, while the magnitude of the saving may not be as much as is claimed in such careless statements, the experience of the last few years is leading to better and more economical designs of freight engines. Large drivers were in disfavor for years because they were usually accompanied by small cylinders, and the combination did not succeed in producing the required tractive effort. Three and four pairs of driving wheels with moderate weights on them were used because track and bridges would not permit of heavy weights per wheel and because it was feared that tires and rail heads could not endure heavier loads without rapid flow of the metal and consequent destruction to both. Now we know better and the conditions on many roads have changed. Loads as high as 46,000 pounds per pair of wheels are believed to cause no damage to large tires or to heavy rails, and modern track and bridges are considered safe under such loads. Consequently, with the higher wheel loads permissible, a weight formerly put on four pair of wheels can now be carried on three pairs, and the weight that used to be the maximum for three pairs is now readily carried on two. The internal friction of the engine and the number of moving parts is thus reduced, with economy as the result. The higher steam pressures and larger boilers and cylinders now used in combination with relatively large drivers for freight engines, have made the large drivers a success. Their use has likewise resulted in economy through reduced piston speed and less friction, and the smaller cost of repairs. That these facts are realized by the mechanical departments of railroads is evident from the present tendency toward larger drivers and fewer of them for freight engines, the consolidation type when used being justified by a great weight on the drivers. But while the saving in wear and tear and in fuel justify these reforms, the fuel saving cannot reach 46 per cent., for the simple reason that the total loss from these causes was not that much.

THERMAL TESTS OF CAR WHEELS.

A correspondent, who modestly asks that his name be not used in connection therewith, has sent us an account of some interesting tests which he made of car wheels, after reading the article in our June number describing the experiments which were made in Altoona. The heat he says which was applied by the tests was in excess of anything possible from the application of brakes. A band of molten metal 1½ inches thick by 4 inches

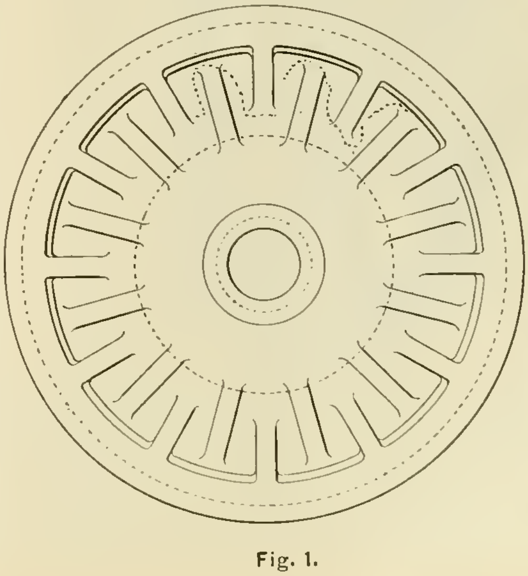


Fig. 1.

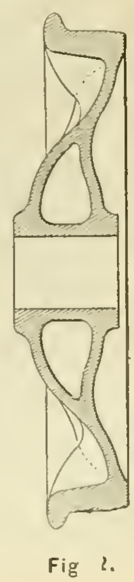


Fig. 2.

deep was poured around the rims as in the Albina tests. If the wheels were removed at once, as soon as the molten metal was set, the plates or brackets would not crack, but if allowed to remain any length of time they would. The wheels were 33 inches in diameter of what is called the double-plate pattern shown in Figs. 1 and 2. The brackets or ribs on the back of the wheel were arranged as shown in Fig. 1; that is, each alternate bracket extended from the rim inward, and those between extended from the inner plate outward as shown in Fig. 2. The object of this arrangement is to relieve the strains from contraction after the wheel is cast, and it is also thought that with ribs arranged

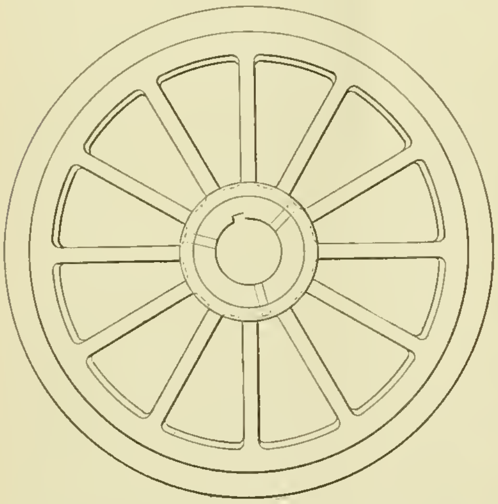


Fig. 3.

Fig. 4.

in this way wheels have greater strength to resist the strains to which they are subjected in service.

In the tests which were made this form of wheel did not crack until two minutes after the metal was poured around it, and, as has been stated, if they were removed from the band of molten metal immediately after it was poured, neither the plates nor the ribs were broken. The form of the crack was peculiar, and is represented by the dotted line in Fig. 1, and, as will be seen, it did not extend across any of the ribs or the rim, the plate only being fractured. In such tests, it is said, the rims are heated to a much higher temperature than is possible by the application of the brakes. While the wheels with the brackets arranged, as

shown, did not crack until the rims had been subjected for a considerable time (two minutes) to continuous heat, wheels of the usual "Washburn" pattern cracked almost instantly after the metal was poured around the rim, the fractures occurring through both the ribs and rim, which indicates, as was intimated in the article referred to, that the form of the wheel has an important influence in its capacity to resist such strains, and also that the ordinary "Washburn" pattern is not the best form.

In our article in the June issue on this subject we illustrated by an engraving made from memory a form of cast-iron wheel, which was made by Ross Winans 40 or 50 years ago, and we ventured the observation that it seemed as though a wheel made in that way would not be broken if tested in the manner described. Fortunately the experimenter who made the tests, which are the subject of this article, had one of these wheels which was made by Winans in 1840, of "Connervingo" charcoal iron, and he has sent us a drawing of it, from which Figs. 3 and 4 have been made. This wheel is 30 inches in diameter, weighs 400 pounds, and the hub was made in three parts which had slots or spaces between them which were filled with zinc. The hub was then banded on both sides with wrought-iron rings, which were shrunk on, as shown. There is also a wrought-iron ring shown in Fig. 4, and which was described in our article published in June. This ring was made of round wrought iron, ⅝ inch in diameter, and was cast in the wheels inside of the throat of the flange. The wheel referred to was subjected to the molten iron test, as described, without cracking. It took a minute for that to extend to the hub and two minutes to equalize through the parts of the wheel.

Experiments were also made with an ordinary open-motor-face truck wheel, Fig. 5, by placing a red-hot chill ring or band around the rim. It was allowed to remain on the wheel until it became cool (55 minutes), all the heat, excepting that which was radiated from the outside of the ring, being absorbed by the wheel casting, which was so hot at the expiration of that time that it was uncomfortable to bear the hand on it. The wheel stood the test without cracking or showing any signs of injury.

It will thus be seen that in these experiments the two spoke wheels stood the thermal test without breaking, which is additional testimony to the fact, which was suggested in the article referred to, that the capacity of cast-iron wheels to resist such tests as have been described depends very much upon the form of the wheel, which opens up the interesting inquiry, what is the best form for such wheels?

The experiments here described have great interest in the consideration of a reply to this inquiry. If it is true that spoke wheels are less liable to break than plate wheels it is an important fact and one which it would be worth while to prove by experiment

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

Notwithstanding the wonderful development of the locomotive and what it has accomplished for civilization and the welfare of mankind it must be admitted that it still has many defects, and some of us are still sanguine enough to think that it is susceptible of further improvement.

It may be said, for example, that a pound of average coal contains sufficient potential heat to evaporate about 12½ pounds of water. It will not be far out of the way to say that in ordinary practice the average evaporation is not more than half that amount of water per pound of coal, so that half of its heat escapes out of the chimney, or falls through the grate unutiliz d, or goes to waste. This waste is due partly to imperfect combustion, and partly because the heat in the products of combustion is not communicated to the water in the boiler. It is not uncommon to find a temperature of 800 degrees or more in the smokebox of a locomotive, and as the temperature of steam of 150 pounds pressure p r square inch is only 366 degrees obviously these escaping gases have a capacity for generating a great deal of steam. Besides this the exhaust steam escapes at a pressure of about 15 pounds, and carries with it a great deal of heat which does no work. This is not a new view of the wastefulness of locomotive engines. The subject of improved combustion has been under consideration ever since locomotives and steam engines have been used, and the literature of the subject is now quite beyond the hope of mastering by any one person. Experiments innumerable and inventions which cannot be counted have been made to produce more economical results in the use of coal, but it must be admitted that the progress which is made is very slow, and the saving which is effected is very slight. One of the main lines of road during the past year or two has been equipped with appliances for weighing fuel, and since then the subject has been studied more carefully on that road than ever before, with the result that a very important saving of coal has been effected, but after years of experience and investigation the verdict of the superintendent of motive power of that line, who has had a long experience in his calling, is that the best means for reducing the consumption of fuel is to improve the firemen. This he has done by having accurate reports of what each of them is doing, and then calling them to account when an excessive amount of coal is burned and investigating whether they or the engines are the cause of it. The breeding and education of firemen will not be discussed now, but the possibility and means of effecting economy by changes and modifications of the engines themselves will be considered.

We have recently made some inquiry with reference to the form and proportions of grates, having a vague idea that some grates are probably better than others. Thus far we have obtained but little more information than that contained in the general statement that grates should be adapted to the fuel to be burned on them. One investigator on the subject stated the general principle that "in every case the widest possible opening should be used that would hold the fuel." For burning shavings and wood, he recommended spaces between the bars $\frac{7}{8}$ inch wide; for "egg" and "furnace" anthracite and coke, $\frac{3}{4}$-inch spaces; for bituminous coal, $\frac{5}{8}$-inch; for sawdust and "nut" anthracite, $\frac{1}{2}$-inch; for "pea" coal, $\frac{3}{8}$-inch. In these recommendations authorities did not agree, and the conclusions seemed to be based on the most casual observations, and were not the result of any carefully made investigation or experiments. To such inquiries as we have made, the general reply of the average master mechanic, it is believed, would be only that general statement—that grates should be adapted to the fuel to be burned in them; but when it comes to any specific statements, with reference to the adaptation, our investigations have shown that their opinions are very vague.

Now, there can be no doubt that the intimate contact of air with the fuel promotes combustion, until, as in the case of powdered fuel and coal dust, when mixed with air they burn so rapidly as to become explosives. If the lumps of coal on a fire are too large, combustion is slow and imperfect, and this is also the case if it is fine and closely packed in the grate, as then the air comes in contact with only a small portion of the surface of the fuel. If coal is pulverized into dust, and floats or is blown in a current of air, the latter comes into such intimate contact with the particles of the fuel as to make it burn, as has been said, with the rapidity of an explosion. Between these limits there is almost every degree of perfect and imperfect combustion. As every fireman who understands his business knows, if coal is broken into suitable sized lumps it can be burned much more perfectly than is possible if it is either larger or smaller. It would seem, then, that what should be aimed at in a grate is to give the air access and bring it in contact with the fuel. That grates as at present made are the best which could be adopted for effecting that end seems very doubtful. It seems quite possible to design a grate which would permit air to circulate more freely below and among the fuel than it can as these appliances are now made. At present the top surfaces of grates are made to coincide with a plane flat surface. If instead of being flat this surface were made with projections so as to have interstices below the coal for the circulation of air it would seem as though it would do something to promote combustion.

Notwithstanding the fact that the value of dead plates has often been pointed out, most locomotive grates are still made without them. Attention has been called in these pages heretofore to the fact that it is desirable in all furnaces to keep the flame out of contact with the sides and top, until the process of combustion is completed. It seems quite certain that combustion is retarded and partially arrested when flame comes in contact with any solid substance. The inference from this, therefore, would appear to be that it is desirable to keep the fire away from the sides and ends of a firebox as much as possible, which may be done by putting dead plates all around the grate so that no air will be admitted next to the sides and ends. The question of the most advantageous locality and proportions for dead plates is still a matter about which very little is known.

The most economical rate of combustion is also worthy of consideration. It probably may be either too slow or too rapid for economy, and it seems reasonable to infer that there is some rate which is more economical—at least, under given conditions—than any other. What this rate is we do not know, but as the amount of coal which must be burned in a locomotive firebox varies constantly, it would seem as though an essential for securing the highest economy would be a variable grate, or one in which the opening could be increased or diminished or in which the live and dead portions can be varied at pleasure. With such an appliance, the rate of combustion per square foot of grate could be kept uniform, or nearly so, in all conditions of working, and at the most economical rate.

In stationary boilers down-draft grates have met with a considerable degree of success. Whether they would be equally so in locomotives is of course an open question. The principle on which they operate seems to be a correct one, and there is no apparent reason why it is not applicable to locomotives as well as to stationary service.

It is, of course, true that while it is often possible to gain what is an apparent advantage, yet before it is ultimately realized it is offset by some expense or difficulty which entirely neutralizes the gain. In all such cases it is the algebraic sum alone which counts ultimately. If the + and the — quantities are equal, no matter how promising the former may be, they will be obliterated by the latter.

The attempts which have been made to save some of the heat which escapes up the chimneys of locomotives are in number almost like the efforts to achieve perpetual motion. They have generally been some form of feed-water heaters or steam superheaters. Nothing seems more plausible than a feed-water heater, and the theoretical advantages of superheating have been often shown. Nevertheless, after almost innumerable trials they have all been abandoned. The various considerations always overbalanced those with a + sign. Still, neither of them now seems to be entirely hopeless, even after a vast number of failures. It must always be kept in mind when improvements in locomotives are contemplated that they must be regarded somewhat as a farmer does a reaping machine. This must be ready and capable of cutting the harvest when it is ripe, and above all things must not break down before the work is completed. It is very much so with locomotives. There are periods of harvest time on railroads when it is of the utmost importance that freight and passenger trains should be moved. A breakdown when there is a congestion of traffic is a very serious matter. It does not make much difference how economical a locomotive may be or how well it works when it is in good condition, if it fails at the time when it is most needed, the cause of the failure, no matter whether it is or is not productive of economy, will be condemned. Feed-water heaters have come under this kind of condemnation. It is easy to prove that they will save fuel, but they are apt to prove costly in other ways. The problem is to secure their advantages without incurring the risks referred to. This it is thought might be done if the tubes of a locomotive were somewhat lengthened and their front ends were surrounded with cold feed-water. The escaping gases would thus impart more or less of the heat to the water surrounding the tubes. Now, to carry out this plan, suppose the boiler and the tubes were lengthened about two or three feet and that a plate or diaphragm, similar to a tube plate, was placed in the boiler about two feet back of the front ends of the tubes. The plate should extend upward to about the water line. If now the feed-water was delivered into the space between this diaphragm and the front tube sheet the cold water would be in contact with the front ends of the tubes and therefore more of the heat in that portion of the tubes would be imparted to the water than would be the case if the water outside of them were hot. The front ends of the tubes would thus act as a feed-water heater and there would be no portion of it more liable to fail than the present boiler is. In other words, it would provide a feed-water heater without any of the objections which experience has shown have always attended the use of those which have heretofore been tried.

But the length of an article makes it impracticable to discuss some other features in locomotive construction which seem to be capable of improvement. The consideration of them will be reserved for a future article.

When we consider that the stationary steam plants owned and operated by railroads aggregate hundreds of thousands of horse-power, it is a matter of surprise that the members of the Master Mechanics' Association do not find some subjects in connection with them that would be worthy of discussion at its conventions. From the absence of such topics from the proceedings of the association it might be concluded that railroads believe there are no unsolved problems in connection with their stationary boiler plants and that their practice was up to date in every respect. And yet we have heard it said that there is a chance for great improvement in these very plants, and that the absence of discussion regarding them is only an indication of the indifference with which they are regarded. There may be a great deal of truth in this view of the case. Certain it is that many roads have stationary plants of such large dimensions that the types of boilers installed, the use of automatic stokers, conveyors for coal and ashes, methods of boiler setting, feed-water heaters and other kindred subjects are of considerable importance, and involve economies of no small magnitude. The mechanical department of a railway is, or should be, interested in more than locomotive practice, and a representative association of this class of men might profitably devote some attention to the economies obtainable either by better engines, boilers and appurtenances, or by improved methods of operating the present installations.

NOTES.

The engines of the *St. Paul*, on her recent record-breaking trip, developed a horse-power of slightly more than 1¼ pounds of coal—a most excellent performance, when it is considered that it is an average for an entire trip, during which the engines and boilers were worked hard. The daily consumption of coal was 315 tons.

A French journal publishes drawings of a new method of staying the fireboxes of locomotive boilers. The bolts, instead of passing through the inner sheets, enter part way only, the sheets being thickened at the bolts by small bosses on the water side of the sheet, so as to get sufficient thread to hold the sheet. Such a construction might be possible with copper sheets, but would be of little practical value, while with steel sheets it is next to impossible.

In addition to the tests of four different two cylinder compound mogul engines, the Pennsylvania Railroad has also been measuring lately the coal and water used by Class L passenger engines and the eight-wheeled two-cylinder compound passenger built at Altoona some time ago. The compound is using considerably less fuel than other engines on the same runs. It will be remembered that this engine has 19½ and 31 × 28-inch cylinders and 12-inch piston valves.

The Holman locomotive, that marvelous engine having a pyramid of multiplying wheels between each driver and the rail, being in principle an inverted Fontaine engine, recently hauled a train of two cars at speeds between 60 and 90 miles per hour. There is nothing remarkable about this speed, except the fact that the Holman locomotive made it. The wonder is that it could make the 20 small wheels placed under the drivers spin around at this speed. We have not heard of a saving of coal from the use of the 20 additional wheels and don't expect that any will be found.

In a paper on the design and manufacture of gears, read by S. Groves, M. E., before the Engineers' Society of Western Pennsylvania, the general advantages of short gear teeth are given. The author says that in calculating the horse power of a gear the teeth are usually considered as cantilevers, liable to be broken off at their roots by lever strains. The new departure consists in so proportioning the teeth that the old lever strain was transformed into a shearing strain. To do this the length of the tooth was reduced from .7 to .5 of the pitch, and the flanks so shaped that but one tooth was in contact at a time. These gears are found to run noiselessly and are claimed to have great advantages for large powers and service in which severe shocks are encountered.

At Ashtabula Messrs. M. A. Hanna & Company have recently put in service a coaling barge for placing fuel upon steamers while they are unloading or receiving a cargo. The hull resembles that of a big scow, is 180 feet long, 36 feet beam and contains 16 compartments capable of holding 640 tons of coal. At one end is a small set of engines for the twin screws, by which the barge is propelled about the harbor. At the other end are elevators for lifting the coal from the barge to the steamers. Under the pockets or compartments is a conveyor that delivers the coal to the boot of the elevator. The barge can approach a steamer at the dock from the harbor side and deliver the coal quickly and without interfering with the handling of the cargo.

Trial runs were lately made in Germany, between Berlin and Lubbenau on the Berlin and Gorlitz line. A German contemporary says that for these runs a special express engine of new design with four cylinders and driving wheels of two meters (6 feet 6 inches) diameter was constructed. The trains were of various lengths, amounting sometimes to 100 axles. With a train of 30 axles the highest performance, viz., 106 kilometers (65⅞ miles) per hour, was recorded, being 20 kilometers (12 miles) more than the highest speed hitherto attained by the quickest German train, viz., the Berlin-Hamburg D-Zug, which runs through a distance of 286 kilometers (177½ miles) in 3½ hours, while the speed of ordinary German expresses is only 70 kilometers (43½ miles) per hour. The portions of lines chosen for these runs are nearly level and have few curves.

It is said that a new road 15 miles long is proposed in Northern Michigan to carry ore to Lake Superior from the mines, and that in this distance the total grade amounts to 800 feet. The freight will be almost entirely iron ore, and the cars carrying it will return empty to the mines. It is suggested that the cars be run in trains of 10 each, each train being supplied with an electric generator, connected with the axles. The grade is such that the loaded cars would run by their own weight, and the dynamos generate a current, which could be taken off upon a trolley wire and used to haul the empty cars back. It is thought that the difference in weight of the loaded and empty cars will give power enough to overcome all leakage, friction, etc. The engineers are figuring on using the dynamos as motors on the return trip, and thus saving expensive machinery.

It was shown by M. H. Moissan, about three years ago, that when iron was saturated at 3,000 degrees C. with carbon, and then cooled under a high pressure, a portion of the carbon separated out in the form of diamond. It occured to M. Rossel, *Comptes Rendus*, July 13, that the conditions under which very hard steels are now made should also result in the formation of diamonds; and an examination of a large number of samples of such steel has shown that this is really the case. The diamonds are obtained by dissolving the metal in acid, and then subjecting the residue to the action of concentrated nitric acid, fused potassium chlorate, hydrofluoric and sulphuric acid successively. The crystals are very minute—the largest attaining only 0.5 millimeters in diameter, but *Nature* says they present all the chemical and physical properties of true diamonds.

In a paper by Mr. Price Williams, written to prove that the terminal charges admissible by the British Board of Trade railway rate schedules were inadequate, he quotes traffic statistics from the London & Northwestern Railway to show the large proporion of receipts absorbed for station or terminal charges. The cost of running passenger trains is given as 2s. 5½d. per train-mile, of which 11½d., or 38.8 per cent., is for terminal charges. In the case of freight traffic the expenses are 4s. 11¾d. per train-mile, and of this the terminal charges absorb 3s. 2d., or 63.57 per cent., while of the 1s. 1d. expenses involved for each mile run by mineral trains 4¾d., or 37.13 per cent., are required for station terminals. Undoubtedly the percentages are lower in this country where the average haul for both freight and passengers is much greater, but we think it will be found upon investigation that there are large savings possible here by better and more enlightened practice in and about terminals.

In the operation of water-tube boilers a good automatic feed is a valuable aid in maintaining the proper water level. Mr. Yarrow, well-known in England for his work as a shipbuilder, and for the water-tube boiler he has invented and built for many government vessels, has in some recent boats adopted an automatic feed invented by Mr. Mariner, a manager in the Yarrow works. The system consists in feeding each boiler separately by a Worthington donkey pump, and placing the mouth of the steam pipe for supplying the donkey close to the water level of the boiler. If the water rises too high it will enter the donkey steam pipe and choke the cylinder with water. Then the donkey will almost stop. If the water level falls, then the donkey will work fast and pump the level up again. It has been found that when the water enters the steam cylinder the pump does not pound in an objectionable manner, as might perhaps be expected. The pump does not stop when the water enters the steam pipe, but runs slowly because the steam cylinder is larger than the water cylinder, the pump actually taking more water out of the boiler than it puts in. The heat in the water taken from the boiler is not lost, but is returned to it. It is said that in a recent three-hours' trial of a torpedo boat having this feed, the valves were not touched once.

The steamship *Germanic*, of the White Star Line, is to have a new set of engines built by Messrs. Harland & Wolff. The old engines were compound with two high-pressure and two low-pressure cylinders, arranged with the high-pressure cylinders on top of the low. These engines propelled the boat across the Atlantic 422 times, or a distance of over 1,000,000 miles. The progress in marine engineering during the last twenty years is well illustrated by a comparison of the old with the new engines. The old engines had two high-pressure cylinders, 48 by 60 inches, and two low-pressure cylinders 83 by 60 inches. The boiler pressure was 60 pounds, and at a speed of 50 revolutions they developed 5,700 indicated horse power. The boilers had 19,500 square feet of heating surface and 680 square feet of grate. The new engines are triple expansion, with cylinders 35½, 58½ and 96 inches in diameter and 69 inches stroke. The steam pressure has been increased to 170 pounds, and the new boilers have 18,169 square feet of heating surface and 558.6 square feet of grate. The new engines develop 6,500 horse power.

The construction of the Bergen Railway in Norway is now in full progress, and is attended with more engineering difficulties than have hitherto been met with in railway construction in that country. One of the most interesting features of the line is a tunnel 17,570 feet long. The snowfall in the country traversed by the line has been studied. It varies considerably; *Engineering* says that in some winters the depth averages three feet or four feet, while in others it is more than six feet. On the more exposed spots there is generally but little snow, while in hollows it may be 12 feet to 16 feet deep. The Voss-Tangevand section (about 46½ miles) rises from a minimum of 180 feet to a maximum height above the level of the sea of 4,330 feet. This section will entail an expenditure of about £800,000, of which £150,000 will be required for the Gravelhalsen tunnel, the construction of which has been contracted for by a firm of Norwegian engineers. The works on the west side of this tunnel were commenced last autumn, and the rock has so far principally consisted of a hard slate. Operations are now about to begin at the other end of this tunnel, the completion of which is fixed for Oct. 1, 1903. At both ends water power is available for the working of boring machines, ventilators, &c. A large portion of that section lies above the forest boundary.

In a paper read before the American Society of Mechanical Engineers by J. M. Whitman, on the effect of retarders in the fire-tubes of steam boilers, the results of experiments are given and the following conclusions derived therefrom: 1. Retarders in fire-tubes of a boiler interpose a resistance varying with the rate of combustion. 2. Retarders result in reducing the temperature of the waste gases, and in increasing the effectiveness of the heating surface of the tubes. 3. Retarders show an economic advantage when the boiler is pushed, varying in the tests from 3 to 18 per cent. 4. Retarders should not be used when boilers are run very gently, and when the stack draft is small. 5. It is probable that retarders can be used with advantage in plants using a fan or steam blast under the fire, or a strong natural or induced chimney draft, when burning either anthracite or bituminous coals. 6. Retarders may often prove to be as economical as are economizers, and will not, in general, interpose as much resistance to the draft. 7. Retarders can be used only with fire-tubular boilers. 8. The economic results obtained on the boiler tested are ideal, showing that it was clean, the coal good in quality, and the firing skillful. With retarders the tubes are more effectively cleaned than without their use. 9. The tests prove that the marine practice of using retarders is good, and that the claim, often advanced, that they show from 5 to 10 per cent. advantage, holds, whenever the boiler plant is pushed and the draft is strong.

If the building of the battleship *Oregon* had been a co-operative enterprise in which nine-tenths of the men of the Pacific coast had personally participated, the satisfaction, not to say self-satisfaction, of the population could scarcely be more ingeniously displayed. The *Oregon* has revealed to the Pacific coast that it can build ships with the best, that the Union Iron Works of San Francisco can even beat the yards of the Cramps, for the new battleship's maximum of 17.34 and average of 16.79 take what is known in the world of battle as the belt. The workmen of the yards were only a little more demonstrative than the rest of the population when they tied ropes to the carriage of Irving M. Scott, the *Oregon's* builder, decked the same with flowers, and dragged him about, hundreds strong, as in a triumphal car. Mr. Scott made a speech to the men who had done the actual work on the battleship, recalled the Eastern taunt of a few years ago that the Union Iron Works constituted only a plant on paper, and, holding up some of the flowers, announced that he would save them for a bouquet to lay on the grave of the once-scornful Cramps. It has been proved that the Pacific coast can build war-ships; magnanimity and a sense of humor will come later.—*Harper's Weekly.*

The East Coast Route between London and Scotland has put some beautiful new trains in service recently. The cars have numerous features that are American. They have corridors the length of the cars, end doors, Gould vestibules, couplers and platforms, Westinghouse brakes, and car-heating apparatus of American manufacture. The cars are each 65 feet long. The construction of such cars is not without its significance. *Engineering* says in commenting upon the new trains: "After a very long life the British railway carriage with its independent compartments begins to show signs of having passed its meridian." It is to be noted, nevertheless, that this innovation is on a long distance train, and it is probable that if it finds favor at all it will be confined to long distance travel. Mr. Worsdell, Locomotive Superintendent of the North-Eastern Railway, has designed and constructed five express engines for these East Coast trains. The cylinders are 20 inches in diameter, and have a stroke of 26 inches. There are four coupled wheels 7 feet 7¼ inches in diameter, and there is a four-wheel bogie. The boiler is 4 feet 4 inches in diameter and over 11 feet in length. The firebox is 7 feet long, and the center of the boiler from the rails is over 8 feet. The boilers are constructed to carry a pressure of 200 pounds per square inch. In addition to the five engines already completed, 10 others are under construction, and a large number of tenders are being fitted up with the water scoop. It is evident, therefore, that the East Coast Route is ready to compete for the traffic to Scotland, either by excellence of accommodation or by a good showing in another "race to the north."

In the evening of August 8, a peculiar accident happened at the Brooklyn Navy Yard. The caisson or gate of dry dock No. 2 gave way and as the dock was empty at the time the inrush of water tore a number of vessels from their moorings. A pile driver, a lumber lighter and the torpedo boat *Ericsson* were carried into the dock and the latter's bow was badly damaged. The steam launch of Commodore Sicard was wrecked and sunk inside of the dock. The war vessels *Atlanta*, *Katadin*, *Terror* and *Puritan* were carried into the channel and toward the dock by the current, but were caught and towed back to their moorings before any damage was done them. The dock and the gate were both damaged and the total bill for repairs is variously estimated to be from $100,000 to $250,000. The gate is of steel and was ballasted with rock which had nearly all been removed preparatory to putting a ballast of concrete, and to its lightened condition is attributed the accident.

An interesting method of testing lubricants when a regular oil tester is not at hand, but where electrical apparatus is available, was recently described by Mr. P. MacGahan, in the *Electrical World*. It consists of employing a shaft driven by a small shunt wound electric motor and fitting it with two bronze or babbitt metal boxes, so arranged that a known weight can be applied to them and the lubricant properly introduced. The speed of the motor can be regulated within one per cent. by means of a water barrel in the armature circuit and rheostat in the field circuit. The power supplied to the motor is observed by means of a watt-meter. The watts required when there is no pressure on the bearing is deducted from the readings obtained when the pressure is put on. From the watts used the speed of the rubbing surfaces and the pressure, the co-efficient of friction can be accurately determined. The equation

$$F = \frac{W \times 44.2}{S}$$

gives the friction in pounds, W being the watts consumed, S the speed of the rubbing surfaces in feet per minute, 44·2 the foot-pounds per watt expended, and F the friction in pounds; whence we obtain

$$K = \frac{F}{P} = \frac{W \times 44.2}{PS}$$

where K is the co-efficient and P the total pressure on the bearing.

In an article in the *Iron Age*, Mr. P. Kreuzpointer made the following comparison between test pieces of various lengths and areas. A few results of tests given below will illustrate better than any words the remarkable difference between the extremes of modern test section, where the 8-inch section comes nearest the natural conditions of the full-sized plate or structural member, while the 1-inch or groove section is further from it, hence giving fictitious values. While a test section where elongation is measured in 10 or 12 inches would still be nearer to the ideal, the difference between these and an 8-inch length is so small that it can be omitted in practice, saving thereby a good deal of metal and cost of preparation:

ELONGATION WITH GEOMETRICALLY DISSIMILAR TEST PIECES.

PER CENT.

2½ by ½ inches.	1½ by ½ inches.	½ by ½ inches.	In inches.
67	61	55	1
50	43	40	2
36	31	30	4
30	26	26	6
27	24	23	8

TENSILE STRENGTH.

Test Section. 1½ inches by ½ inch.

Length of section in inches	1	2	4	6	8
Pounds per square inch	72,000	65,1'0	62,700	60,300	59,000

In the last report of the Australian Railway Commissioners particulars were given of a new locomotive, which had been designed under their directions especially to meet the requirements of the New South Wales lines. It is aptly named the "Australian Consolidation" engine and considerable interest has been attracted by the appearance of the first of the engines in steam. The trial runs, it is understood, were most satisfactory, indicating that the new locomotive fully meets all that was desired when it was designed. The New South Wales *Railway Budget* says that the engines, five in number, have recently arrived and have been put together at Eveleigh. They are big engines, necessarily so, to perform the work set them, and have been built by Messrs. Beyer, Peacock & Company, Limited, detail drawings, specifications, etc., having been prepared by the Chief Mechanical Engineer in Australia. The engines are designed in accordance with the English practice permitting of plate frames, copper fireboxes and brass tubes being used. The journals and crank pins are encased in dust proof shields, a very desirable protection in dry climates, such as are met with on many of the New South Wales main lines. These engines have outside cylinders 21 inches diameter by 26-inch stroke, with eight coupled wheels, and a two-wheeled radial truck; the Westinghouse automatic brake is applied to all the coupled wheels. The valve motion is of the Allan straight-link type, with balanced slide valves, and trick ports. The boiler and fire box are constructed on the Belpaire principle, working at a steam pressure of 160 pounds per square inch, and containing a total heating surface of 2,211 square feet, with a grate area of 29.75 square feet. The tenders are of the double bogie type, capable of carrying 3,650 gallons of water and six tons of coal, and are equipped with the Westinghouse automatic brake.

	Ft.	In.
Diameter of coupled wheels	4	3
Coupled wheel-base	15	0
Total wheel base of engine	23	2
Total wheel-base of tender	16	0
Total wheel-base of engine and tender	51	10¼
Total length over buffers	60	3¾
Centers of cylinders transversely	7	0
Width over cylinders outside	9	2¾
Height of center of boiler above rails	7	8

The haulage power (exclusive of engine and tender) that it was estimated the engine could manage on a 2½ per cent. grade was 350 tons, at a speed of 10 miles per hour, and it is said that on the trial runs this has been satisfactorily covered.

The Prussian State railways are experimenting with a new composition of oils and fats for lubricating car axles. The following test was made with the new lubricant on Corridor Car No. 562, running between Berlin and Frankfort-on-Main: The new lubricant was applied in all the eight axle boxes. The method of application was to impregnate 16 cushions, made of a cheap shoddy material, with the new lubricant, and placing these, the one under and the other over the axles in each box. The remaining space was filled up with the composition. The total weight of lubricant thus applied was 16 kilogrammes. The car was run in the regular passenger train service, and after running 5,000 kilometers a slight addition of the lubricant was made in each axle box. At the end of a run of 30,000 kilometers the car was held over at the Berlin station and a careful inspection made. The cushions were removed and weighed, and likewise the composition in the axle boxes carefully taken out and weighed. The cushions and grease were replaced in the boxes with some addition of fresh material, an exact record of weight being kept. This was repeated as each 30,000 kilometers of train services were run by the car. The saving, according to the official figures, comes out at 15.84 marks per 30,000 kilometers of train service, or about one-half of present cost per car. The severest cold weather of Northern Europe does not have any effect on the composition, as its freezing point is 28 degrees Centigrade. On the other hand, the warmest weather does not cause the composition to run. The results of the tests may be summed up approximately as follows: One application of lubricant suffices for 3,100 miles of train service, and in running 55,800 miles the consumption is about 69 pounds, which is about 1½ grains per 100 miles run for each axle box. The Prussian Government pays about 15c. per pound for the composition.

Personals.

Mr. William W. Borst has been appointed Receiver of the Denver, Lakewood & Golden Railroad.

Mr. E. P. Ripley has been elected President of the Sonora Railway and New Mexico & Arizona Railroad.

Mr. H. Fegraus, of Duluth, Minn., has been appointed Chief Engineer of the Duluth & North Dakota.

Mr. J. P. Lyman, General Manager, has also been elected President of the Chicago, Hammond & Western.

Mr. N. Monsarrat has been elected Vice-President of the Columbus, Hocking Valley & Toledo Railway.

C. Millard has been appointed Chief Engineer of the St. Louis, Chicago & St. Paul, with office at Springfield, Ill.

Mr. J. T. Walch has been appointed Master Mechanic and Master Car Builder of the Oregon Central & Eastern.

Mr. Joseph McWilliams is now General Manager of the Marietta & North Georgia, with headquarters at Marietta, Ga.

Mr. Edward Woodbury, of Kalamazoo, has been elected President of the Chicago, Kalamazoo & Saginaw Railway.

Mr. Wm. Rutherford, Superintendent of Motive Power and Equipment of the Plant System of Railways, has resigned.

Mr. John Oliver, formerly for 15 years Purchasing Agent of the Baltimore & Ohio, died at Baltimore, Md., July 15, after a long illness.

Mr. R. B. Levy, Sr., has been appointed Receiver of the Texas, Sabine Valley & Northwestern, to succeed Mr. Leon H. Hart, resigned.

Mr. J. L. Polk has been appointed Acting General Manager of the Gulf, Colorado & Santa Fe, to succeed Mr. B. F Yoakum, resigned.

Mr. Jonathan Evans has been appointed Master Mechanic of the Washington & Columbia River Railway, vice William Saxton, resigned.

Mr. D. W. McLean, Master Car Builder of the Kansas City Fort Scott & Memphis at Fort Scott, Kan., died at Grand Rapids, Mich., July 27.

Mr. Thomas Inglis, Master Mechanic of the St. Louis Southwestern, at Tyler, Tex., died recently. He is succeeded by Mr. J. M. Scrogin.

Mr. William S. McGowan, Jr., has been elected Treasurer of the Hancock Inspirator Company, of Boston, vice Mr. Edward P. Noyes, resigned.

Mr. William Whyte, Superintendent of the Texas Trunk, has been appointed Receiver of that road to succeed Mr. George T. Atkins. His office is at Dallas, Tex.

Mr. Edwin McNeil, Receiver and General Manager of the Oregon Railway & Navigation Company, has been chosen President of the reorganized company.

Mr. J. M. Schoonmaker has been elected President of the Pittsburgh, Chartiers & Youghiogheny Railway to fill the unexpired term of J. H. Reed, resigned.

Mr. D. C. Courtney has been appointed Division Master Mechanic of the Baltimore & Ohio Railroad, at Grafton, W. Va., in place of Mr. S. A. Souther, resigned.

Mr. S. B. Wight, Secretary to President Ledyard, of the Michigan Central, has been appointed Assistant Purchasing Agent of that road, with office at Detroit, Mich.

Mr. W. A. Walden, of Charlotte, N. C., has been appointed Master Mechanic of the Southern Railway at Burlington, N. C., to succeed Mr. T. S. Inge, transferred to Columbia, S. C.

Mr. E. T. Smith has resigned as Purchasing Agent of the St. Louis & San Francisco, and the office is abolished. General Manager Yoakum will hereafter look after the purchase of supplies.

Mr. S. R. Tuggle, Superintendent of Motive Power and Machinery of the Houston & Texas Central, has also been made Superintendent of Motive Power and Machinery of the Galveston, La Porte & Houston.

Mr. Charles Warren, General Manager of the Great Northern, has retired. Mr. James M. Barr, General Superintendent, has been assigned certain duties heretofore performed by the General Manager, and the latter office will be abolished.

Mr. W. E. Guerin has been elected President of the Columbus, Sandusky & Hocking Railroad, to fill the vacancy caused by the resignation of N. Monsarrat. Mr. Charles Parrott has been elected Vice-President, to fill the vacancy caused by the election of Mr. Guerin.

Mr. Edward S. Washburn, Vice-President of the Kansas City, Fort Scott & Memphis, has been chosen President of that road and the Kansas City, Memphis & Birmingham. It is announced that he will also assume the duties of General Manager of the roads named and associated lines.

Mr. Joseph A. Jordan, General Manager of the St. Louis & Hannibal, has been elected Vice-President of the Green Bay & Western, which has but recently been reorganized, to succeed the Green Bay, Winona & St. Paul. Mr. Jordan will continue as General Manager of the St. Louis & Hannibal.

Mr. F. P. Olcott has been elected President and Mr. J. H. Hill General Manager of the Galveston, Houston & Henderson road in Texas. Mr. Hill was appointed to this office some months ago, but has not yet been placed in active charge of the operation of the line, which still continues under the direction of the Operating Department of the International & Great Northern.

Mr. A. L. Studer, Master Mechanic of the West Iowa Division of the Chicago, Rock Island & Pacific, at Stuart, Iowa, has been appointed Master Mechanic of the Southwestern Division, in charge of the Locomotive and Car Department, with headquarters at Trenton, Mo., to succeed Mr. William Gessler, resigned. Mr. J. B. Kilpatrick is given jurisdiction over the West Iowa Division in addition to his other duties.

Mr. Frederick Harrison, General Manager, and Mr. Robert Turnbull, General Superintendent, of the London & North Western Railway, of England, arrived in New York by the Cunard line steamer *Lucania* on Saturday, Aug. 22. These gentlemen are coming over on a tour of recreation and observation, and after two days' stay in New York, will proceed to the Pacific Coast, visiting all places of interest *en route* in the States and Canada, returning to New York in October. They will be entertained by a large number of American railroad officials, and every facilitation will be afforded them to inquire into the American system of railroads, etc.

Mr. Robert Garrett, formerly President of the Baltimore & Ohio road, and the son of Mr. John W. Garrett, who did so much in the building up of the road, died on July 29. Mr. Garrett was born at Baltimore in 1847, and was graduated from Princeton University in 1867. After a short training in the banking house of his father he entered the railroad field, being made President of the Valley road of Virginia in 1871, Third Vice-President of the Baltimore & Ohio in 1879, First Vice-President in 1881, and President in 1884 on the death of his father. In October, 1887, he resigned the Presidency, and Mr. Samuel Spencer became President. During Mr. Garrett's administration the Philadelphia division of the road was built, and the B. & O. express and telegraph lines were built up only to be sold out at a great loss.

Equipment Notes.

Five locomotives are under construction at the Brooks Works for the Chicago, Rock Island & Pacific Railway.

The Michigan Central is building three new locomotives, two switch and one passenger, at its St. Thomas shops.

It is stated that the Lake Shore & Michigan Southern will order soon 12 or more locomotives and about 900 freight cars.

The Chicago, Rock Island & Pacific Railway has ordered 100 coal cars to be built by the Michigan Peninsular Car Company.

A contract for building ten Page dump cars has been let to the United States Car Company, and will be built at Hegewich.

The Great Northern has placed an order with the Brooks Locomotive Works for 12 mogul engines with 19 by 26-inch cylinders.

It is reported that the Chicago & Northwestern contemplates adding about 5,000 new freight cars to its equipment during the year.

The Indiana Pipe Line and Refining Company has placed an order of fifty 8,000 gallon tank petroleum cars with the Terre Haute Car Works.

The Illinois Central has contracted for the construction of six ten-wheeled and eight eight-wheeled passenger locomotives, five moguls and four six-wheeled switchers. This order is divided between the Brooks and Rogers Locomotive Works.

The Pittsburgh Locomotive Works recently delivered to the Seaboard Air Line twelve ten-wheel engines with cylinders 19 by 24 inches. They have also shipped lately two six-wheel connected side tank engines with cylinders 13 by 20 inches for the Ota Railway of Japan.

The records of the Georgia courts show that the cars recently ordered by the Georgia Railroad from the Ohio Falls Car Manufacturing Company are to cost as follows: Two hundred ventilated box cars, $434 a car; 65 drop-bottom gondolas, $340 a car; 50 platform cars, $286 each, and 10 stock cars, $414 each.

In stating in our July issue that the Richmond Locomotive Works had not received an unqualified order for alterfng over 60 Big Four engines to the compound system, we were in error. The order has been given for the entire 60 engines, but, of course, the work of alteration will be carried out only as the engines come in the shop for general repairs.

H. K. Porter & Company, of Pittsburgh, some time ago secured a contract for equipping the Eckington and Soldiers' Home Street Railway of Washington with traction cars and compressed air motors. The new cars will resemble ordinary cable cars and will be about 20 feet long. The power will be placed beneath the seats and the floor of the car. The air will be stored in eight iron retorts nine inches in diameter and as long as the car. The air will be stored at a pressure of 2,000 pounds to the cubic inch. The air pressure in the storage tanks is reduced before used in the motor and is to be heated by passing it through hot water. The power is regulated by ordinary levers, and the system is almost identical with a steam or compressed air locomotive.

Report of the Committee on Fire-Proofing Tests.

The following report, addressed to the Tariff Association of New York, the Architectural League of New York and the American Society of Mechanical Engineers is of unusual interest. The joint committee appointed to investigate and test fire proofing for structural metal in buildings and to obtain data for standard specifications, is as follows: S. Albert Reed for the Tariff Association, Geo. L. Heins for the Architectural League and H. de B. Parsons and Thomas F. Rowland, Jr., for the American Society of Mechanical Engineers. The committee, after having effected its own organization, determined to add to its numbers by the creation of an Advisory Board. This step was taken for the purpose of more widely increasing the interest taken in the experiments, and also to prevent, as far as possible, the impression that the work was of a sectional or local character. The names of the gentlemen who accepted invitations to serve on this Advisory Board are as follows:

Edward Atkinson, President Boston Manufacturers' Mutual Fire Insurance Company.
Osborne Howes, Secretary Boston Board of Fire Underwriters.
Charles A. Hexamer, Secretary Philadelphia Fire Underwriters' Association.
W. Martin Aiken, Supervising Architect, United States Treasury Department, representative Illinois Chapter, American Institute of Architects.
George B. Post, New York Chapter, American Institute of Architects.
Stevenson Constable, Superintendent of Buildings, New York.
F. H. Kindl, Structural Engineer, Carnegie Steel Company.
John R. Freeman, Chief Instruction Department, F. M. I. Companies.
Henry Morton, President Stevens Institute of Technology.
C. H. J. Woodbury, member American Society of Civil Engineers.
H. B. Dwight, Dwight Survey and Protection Bureau, New York.
F. C. Moore, delegate New York Board of Underwriters to Board of Examination of Department of Buildings.
Wm. A. Wahl, Secretary Franklin Institute, Philadelphia.
John T. Williams.

The committee publicly thanks the parties mentioned below for their offers of assistance, namely: The Continental Iron Works, for permission to use part of their yard and for numerous courtesies which have been extended to the committee from time to time; the Carnegie Steel Company, Limited, for their offer to furnish all the structural steel that the committee may need; J. B. & J. M. Cornell, for their offer to furnish the cast iron columns for which the committee may ask; Sinclair & Babsen, for their donation of 75 barrels of Alsen cement; the Lorillard Brick Works Company, through Henry M. Keasbey, for 54,000 common bricks; Henry A. Maurer, for his donation of 14,000 fire bricks and 14 barrels of fire clay.

The report says:

During the winter just past your committee erected a testing plant, as shown in the accompanying photograph, Fig. 1. The gas producer in the background is 9 feet in diameter by 12 feet in

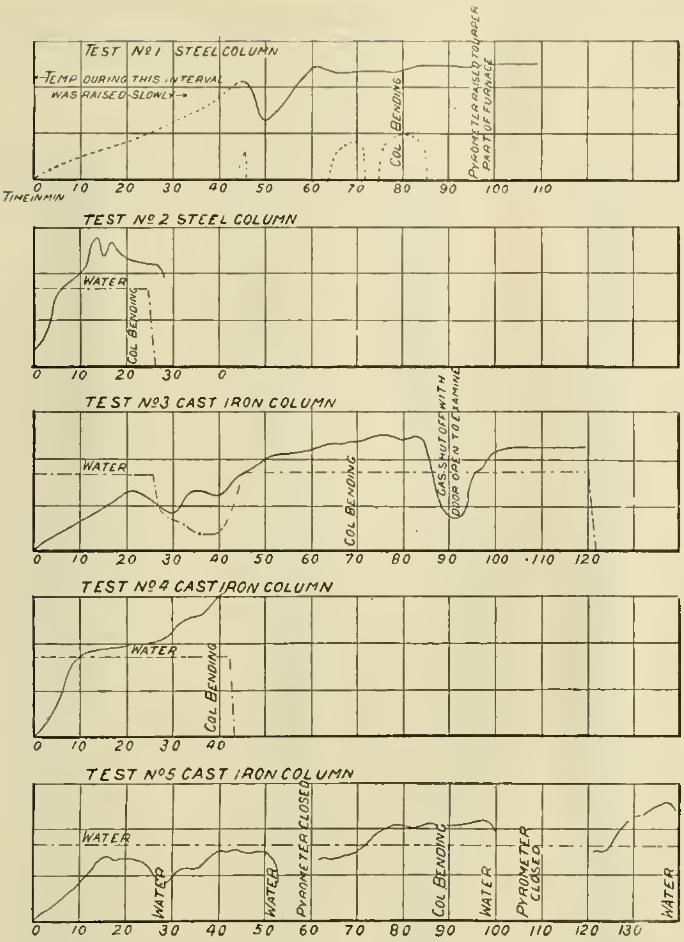
Fig. 1.—View of Testing Plant.

height, and is equipped with a hopper valve on top. Gas is generated by means of steam from the boiler, as shown, and carried into the furnaces through pipes, as clearly indicated in the photograph. The foundation shown on the left is ready for the erection upon it of a furnace for testing beams and floors. Its dimensions are: length, 27 feet; width, 12 feet; but it can be arranged to take larger beams if so desired. The furnace shown on the right is for testing columns, and is 14 feet square, outside measurement.

The arched roof is made of fire brick and is independent of the side walls, being supported by outside corner posts. The walls are of common brick, but can easily be changed so that experiments can be made on other materials. One side wall and the end wall with the door are 12½ inches in thickness; the rear wall is 8½ inches, and the fourth wall is 4 inches inside, 2 inches air space and 8½ inches outside, making a total thickness of 14½ inches.

The floor is covered with fire brick, with openings left for the branch gas pipes and air spaces to support the combustion. These branch gas pipes are 4 inches in diameter, capped with tuyeres reduced to 2 inches. In order to increase the temperature when desired, a barrel of naphtha is connected by means of a small pipe and blown into the gas pipe at the Y-branch by means of a steam jet.

The column is placed in compression by means of a hydraulic ram underneath, resting on three 24-inch I-beams the same as those across the top of the furnace shown in photograph. In order to keep the entire length of the column within the furnace filler blocks of cast-iron are placed between the ends of the column and these I-beams. The hydraulic ram is 12 inches in diameter and the water



Full lines show temperature—each vertical space equalling 500° F.
Broken lines show load—each vertical space equalling 50 tons.

Fig. 2.—Diagram of Tests.

pressure can be carried to 2,500 pounds per square inch. The temperature is measured by means of a Uehling & Steinbart pyrometer

The money to carry out this work has been advanced by various parties. The money expended up to July 22, 1896, is $3,103.30.

Your committee decided that it would be best to make the tests according to the following programme:

First.—That a series of tests be made on steel and on cast-iron columns, without any fire protection whatever. These tests then to be taken as a basis of comparison with those that were to follow.

Second.—That a series of tests be made with similar steel and cast-iron columns, protected with different materials and in different manner.

Third.—That a series of tests be made on unprotected beams and girders.

Fourth.—That a series of tests be made on protected beams and girders.

It has also been proposed that each series be be divided for test both with and without water.

Your committee has communicated with many manufacturers of fireproofing materials, and has been informed that these manufacturers will submit their materials for purposes of tests.

RESULTS.

The result of this series of tests is shown in the accompanying diagram, Fig. 2, where the solid line represents the temperature and the dotted line the load on the column.

Test No. 1 was made on a steel column, when the temperature was rapidly raised. Test No. 3 was made on a cast-iron column under similar conditions. Both columns began to fail as soon as they showed "red."

Test No. 2 was made on a steel column, when the temperature was raised more slowly than in the other tests just described, and test No. 4 was made on a cast-iron column under similar conditions. Both these columns failed when they began to show "red," although the time was longer than in Tests 1 and 3.

Test No. 5 was made on a cast-iron column, a jet of water being thrown upon it through a ¾-inch nozzle. The column was first heated to 675 degrees and then quenched with water without injury. The heat was then slowly raised again to 775 degrees and the column again quenched with water. The heat was then raised slowly to a temperature of 1,075 degrees and the column, which then showed a "dull redness," was again quenched with water. The heat was then raised again to 1,300 degrees and the column, which now showed a "bright red," was again quenched with water. The column was beginning to yield by bending just before the last application of the water. The column was apparently unaffected by water, although it failed by bending under the load the same as in Cases 3 and 4.

Column Test No. 1, May 19, 1896.—Fire test without water; steel column.—The walls of the furnace were of common brick, as described, and the door was closed with a double thickness of sheet iron, which made the opening practically tight. The column was a Carnegie steel box channel, of the dimensions as shown in Fig. 2, and was unprotected. The weather was clear and warm, with only a slight breeze from the west. The temperature of air 80 degrees Fahr., in the shade. The gas producer was fired the day before, with valve closed against the furnace. The packing in the hydraulic cylinder leaked and a fitting of the pipe gave out as test started. These causes delayed the use of the water pressure.

LOG.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
10.35	....	....	Wood fire lit.
10.45	....	....	Gas turned into furnace.
11.13	....	....	Pyrometer put in furnace through lower hole, 2½ feet above the furnace floor, with point 12 inches from column.
11.20	1.050	....	Pressure on column. Light load. Pyrometer point 24 inches from column.
11.36	1,225	....	Half faucet of naphtha.
11.40	1,175	14.13	Water pressure on.
11.41	1,1-0	28 26	Quarter faucet of naphtha.
11.46	1,175	..	Pressure off, water valve repacked.
11.50	1,175	....	Closed all air openings. Water pressure on.
11.55	1,200	48.06	Column began to show "red."
11.56	1,210		Column began to yield.
1 .59	1,225	42.41	Hydraulic pressure falling fast.
12.25	1,250	....	Gas shut off.

The column would have failed sooner if the working load of eighty tons could have been used. After the column was removed

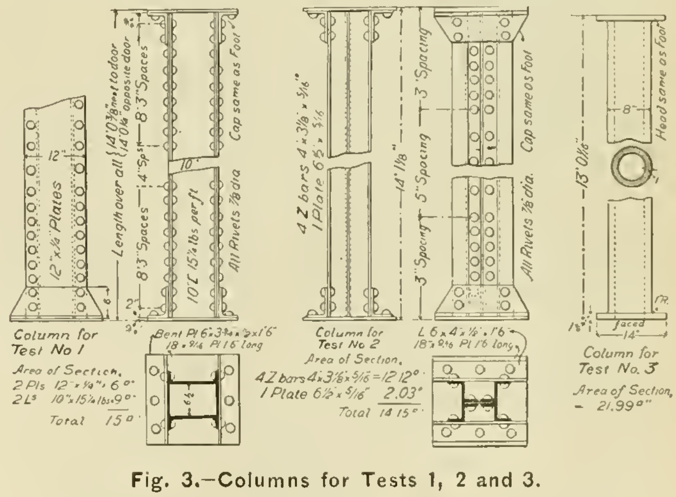


Fig. 3.—Columns for Tests 1, 2 and 3.

from the furnace a photograph, Fig. 4, was taken. The brick walls cracked, the greatest damage taking place where one wall was bonded into the next and the cracks at these places extended through the bricks. Along the horizontal joints the walls cracked most on the bond courses. All the walls were hot, the eight-inch wall being too hot to hold the band in contact with it.

STRENGTH OF GORDON'S FORMULA.

Breaking strength per square inch, 45,630 pounds.
Area of cross-section 15 square inches.
Breaking load, 15 by 45,630, 684,45 pounds, 342 tons.
Actual greatest load, cold, 141.4 tons, with no change of form.

Column Test No. 2, May 27, 1896.—Fire test without water; steel column; furnace same as Test No. 1.—The column was a Carnegie steel Z bar, as shown in Fig. 3, and was uncovered. The weather was clear and warm, with a moderate breeze from the northwest. Temperature of air, 80 degrees Fahr. in shade.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.23	80	....	Pyrometer point 3 feet from column.
2.21	200	84.8	Wood fire lit.
2.30	650	84.8	Gas turned on.
2.35	1,000	84.8	One-quarter cock of naphtha.
2.38	1,375	84.8	Naphtha closed.
2.40	1,125	84.8	One eighth cock of naphtha.
2.44	1,175	84.8	Naphtha cock closed to "dropping"
2.45	....	84.8	Pyrometer moved to 2 feet from column as flame touched point.
2.46	1,125	84.8	Column began to yield.
2.47	1,124	84.8	Column yielding fast.
2.49	1,100	84.8	Impossible to maintain hydraulic pressure.
2.51	1,100	84.8	Pump and gas stopped.
2.52	900	84.8	Pyrometer closed.

STRENGTH OF GORDON'S FORMULA.

Breaking strength per square inch, 42,820 pounds.
Area of cross-section, 14.15 square inches.
Breaking load, 14.15 by 42,820, 605,900 pounds, 303 tons.

Column Test No. 3, June 30, 1896.—Fire test without water; cast-iron column; furnace same as Tests 1 and 2.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, as shown in Fig. 3, and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York. The weather was clear and warm, with a slight breeze from the southwest. Temperature of air, 75 degrees Fahr.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.32	....	14.1	Wood fire lit.
2.45	....	84.8	Gas lit, door being closed.
2.50	....	84.8	Pyrometer in place, 18 inches from column.
2.51	575	84.8	
2.57	625	84.8	Gas shut off to poke producer.
3.00	475	56.5	Removed some loose bricks that interfered with tuyeres.
3.05	450	28.2	Gas turned on, door closed.
3.06	650	15.5	
3.08	667	....	Air openings closed.
3.12	600	11.3	Door down to arrange bricks.
3.13	650	....	Door closed.
3.13½	750	....	Naphtha valve opened one-half.
3.37	1,125	84.8	Slight redness reported by some.
3.40	1,137	84.8	Column bent slightly.
3.55	1,200	84.8	Gas shut off, door down, column decidedly red and bent.
4.04	387	84.8	Gas on and door closed.
4.08	925	84.8	No naphtha.
4.09	925	84.8	Naphtha turned on one-half cock.
4.32	1,125	84.8	Gas shut off, stopped pumping.

Strength by Gordon's formula was as follows:

Breaking strength, 902,000 pounds.
Safe load ⅕ by 902,000, 180,400 pounds, 90.2 tons.

The result of test No. 3, is shown in Fig. 5.

Column Test No. 4, July 6, 1896.—Fire test without water; cast-iron column furnace same as Tests 1, 2 and 3.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core by the Cornell Iron Works, New York. The column was the same as illustrated in the cut (Fig. 3), with the following exceptions: Length over over all, 13 feet ¼ inch thickness of flanges, 1⅝ inches flanges re-enforced by four ribs each seven-eighths inch thick, reaching from outer end of flange to cylinder at an angle of about 45 degrees.

LOG OF TRIAL.

Time. H. M.	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.22	....	....	Wood fire fire lighted.
2.25	....	84.8	Gas lighted.
2.28	....	84.8	Pyrometer placed 18 inches from column.
2.29	....	84.8	Door closed.
2.30	675	84.8	
2.49	1,000	84.8	Naphtha used, one-quarter cock.
2.51	1,100	84.8	
2.52	1,125	84.8	More naphtha, three-eighths cock.
2.53	1,200	84.8	More gas.
2.54	1,300	96.1	
2.57	1,350	84.8	Column bending.
2.59	1,350	84.8	More naphtha, half cock.
3.01	1,375	84.8	Color reported.
3.03½	1,525	84.8	Column yielding fast.
3.05	1,550	84.8	Column broke suddenly.

The fracture occurred at the center of the column, Fig. 6, where the deflection was the greatest. There was a crack about 5 inches long about 7 inches above the fracture on the convex side of the column, showing that the column first pulled apart on the outside of the bend. No water was thrown on this column during the test.

Column Test No. 5, July 10, 1896.—Fire Test with Water. Cast-Iron Column. Furnace same as Tests Nos. 1, 2, 3 and 4.—The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core, by the Cornell Iron Works, New York. The column was the same as illustrated in Figure 7, with the following exceptions: Flanges were 1⅝ inches thick, and were re-enforced with four ribs, as in test No. 4. There was a slight defect in this casting, there being a porous portion a few inches long on one side about 3 feet 6 inches from the lower end.

Water was thrown upon the column through about 50 feet of

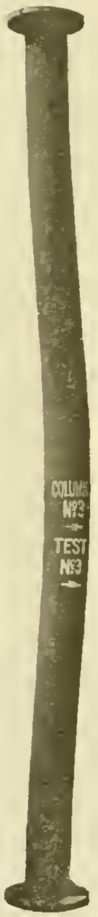


Fig. 5.

Fig. 6.

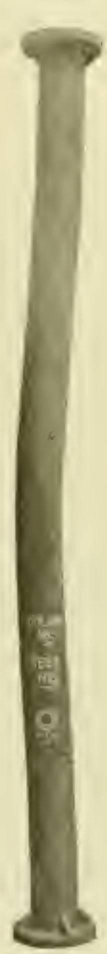


Fig. 7.

Fig. 4.

2½-inch rubber hose and a three-quarter-inch nozzle. The pressure at the hydrant was 50 pounds.

LOG OF TRIAL.

Time. H. M	Pyrometer. Deg. Fahr.	Hyd. pressure. Total load, tons.	Remarks.
2.16	....	84.8	Wood fire lighted.
2.28	....	84.8	Gas lighted.
2.29	600	84.8	Door closed. Pyrometer in place 18 inches from column.
2.36	675	84.8	Pyrometer moved back 5 feet from column.
2.42	525	84.8	Water thrown on column one minute.
2.43	450	84.8	Door open. Fire out.
2.44	400	84.8	Door open. Fire relighted.
2.46	425	84.8	Door closed.
2.58	750	84.8	Pyrometer 3 feet from column.
3.02	750	84.8	Pyrometer 18 inches from column.
3.05	785	84.8	Pyrometer 5 feet from column.
3.09	400	84.8	Water on column half minute. Fire out. Door down.
3.16	....	....	Gas relighted Door closed.
3.19	685	84.8	Pyrometer 18 inches from column.
3.22	700	84.8	More air admitted.
3.35	1,025	84.8	
3.50	1,050	84.8	Column red.
3.55	1,075	84.8	Water on column half minute. Fire out. Door down. More water on column as it was still red.
4.13	....	84.8	Gas relighted.
4.17	750	84.8	Pyrometer 18 inches from column.
4.21	787	84.8	Naphtha, half cock.
4.30	1,250	84.8	Column getting red.
4.31	1,275	84.8	Column bending.
4.34	1,300	84.8	Pyrometer moved back. Water on column one minute.
4.35	....	84.8	Door down and water on column again two minutes.

The result of the test is shown in Fig. 7.

The column was very red when the water was thrown on it the last time. The brick walls and arch roof cracked when water fell on them. The columu was badly bent, but otherwise appeared un injured.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued f om Page* 192.)

VI.—Influence of the Inclination of the Stack Upon the Vacuum.

a. With the Same Bottom Diameter.

It has already been seen and discussed with reference to Plate II., in which the waist-shaped stacks are represented, that, within certain limits, the lowest vacuum is obtained with that stack which, having the same bottom opening, flares out to the largest diameter at the top. Plate VI. under *C* illustrates the same fact, and it is shown in a still more convincing way relatively to the funnel-shaped stacks under *B* in Plate V. In the latter plate the lines of the diagram placed together for two stacks having a diameter of 13.78 inches at their smallest section and with inclinations of one-twelfth and one-sixth respectively.

We see from these diagrams that the full length stack with the straightest sides produces 60 per cent greater vacuum than the stack having the same bottom diameter but a greater flare.

Zeuner reached the opposite opinion in his theory of conical stacks as stated in Section I.

Fig. 55 shows, on a larger scale, the relationship of the two conical stacks to each other when the nozzle diameter is 4.74 inches. The nozzle distances (abscissas) are here shown in a scale of $\frac{1}{10}$ their full size, while the corresponding vacuum (the ordinates) is shown on a scale of half size. But it is possible, as we have al-

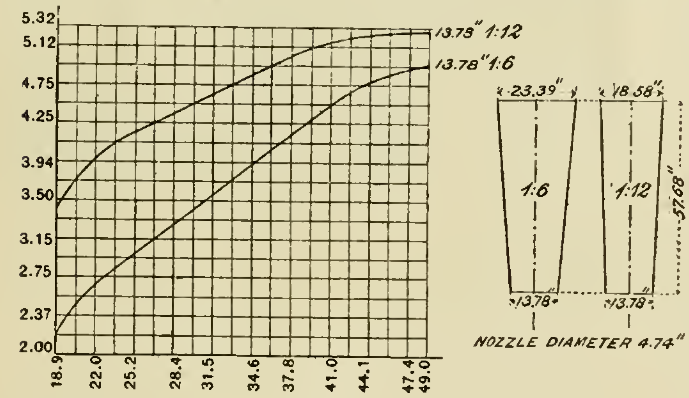


Fig. 55.

ready demonstrated, to obtain the same action with both stacks by using a greater nozzle distance with that stack which has the greater flare. According to Plate V. this must average about 12.60 inches greater in the stack with $\frac{1}{6}$ inclination than in the one having $\frac{1}{12}$.

The lines of the diagrams under *A* in Plate VI. show the same thing for stacks that have been shortened 19.68 inches at the top.

b. With the Same Top Diameter.

In Plate V., under *C*, two groups of stacks of three each are shown; they have the same top diameter but different flares or inclinations. In one group the corresponding diameters are about 2 inches larger than in the other. Both groups exhibit the same contour of lines, which shows that:

With the same top diameter, that stack creates the greatest draft which has the smallest bottom diameter and which is contracted the most toward the bottom.

The lines of the diagram under *B* in Plate VI. show the same thing. Here two stacks are compared that have been shortened 19.68 inches at the top and which have a flare of $\frac{1}{6}$ and $\frac{1}{12}$ respectively as before. In consequence of the large amount that has been cut off from the top and the slight differences in the diameters resulting therefrom, the vacuums belonging to the two stacks do not differ so much from each other as they do in the case of the longer stacks represented in Plate V.; but the more sharply contracted stack always produces a draft about 19 per cent. greater.

In Fig. 56 we have given, on a larger scale the diagrammatic lines of two full-length stacks of the same top section, but with waists of different diameters, the nozzle diameter for both being 4.74 inches. The vacuums are represented by the ordinates and the

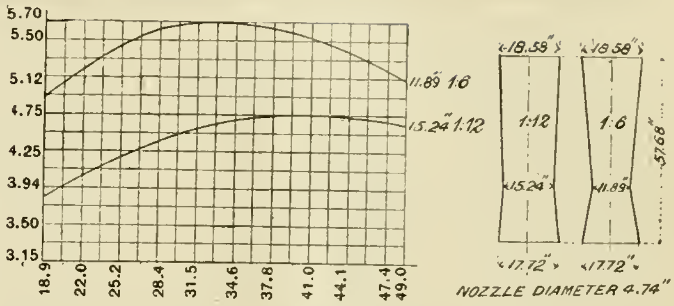


Fig. 56.

corresponding nozzle distances by abscissas. We see from the diagram, that the vacuum here increases about 1.18 inches, or 28 per cent., if the stack having a waist diameter of 15.24 inches is changed for one having a diameter of 11.89 inches, the diameter at the top remaining unchanged. These facts, taken in connection with that graphically shown in Fig. 55 for stacks having the same bottom diameter, form the basis for the statement made in section X., that in the theories of locomotive exhaust nozzles and stacks the equalization for the conicity of the stacks must be made in another way, as is done.

The curves under *C* of Plate V. are not instructive when read in any other way. At the right the waist shaped stac s have the sides shown prolonged in the dotted lines to the bottom, and the smallest diameter, which would then be formed, marked.

By making a comparison of the curves we can readily determine the influence of the foot of the stack, as discussed in the preceding section. For short nozzle distances, in which the current of steam does not present a sufficiently large surface for drawing in the air, the funnel-shaped stack with a flare of ½ (especially where the diameter is small) has a weaker effect than the waist-shaped stack with the same flare; but when the nozzle distance drops to about 0.4 of the total height of the stack, the two are about equal in effectiveness, while for greater distances the funnel-shaped stack no longer appears to be superior to the waist-shaped. For all the abscissas of Plate V. both stacks have the same total heights, and agree perfectly in having their upper sections 40.02 inches long, but the difference lies in the fact that, with the funnel-shaped stacks the nozzle is always about 17.52 inches nearer the smallest section, which has a diameter of 15.75 inches than is the case of the waist-shaped stacks, with a waist 17.2 inches in diameter. Now, according to Section VIII. we find that a confined jet of steam in the experimental apparatus had a flare of about 1 in 2.4; so that at a distance of 29.92 inches (760 millimeters) from the nozzle it would have an approximate diameter of $\frac{29.92}{2.4}$ + the diameter of the nozzle, that is with a nozzle 4.74 inches in diameter it would be

$$12.46 + 4.74 = 17.2 \text{ inches.}$$

Thus at about 29.92 inches from the nozzle opening the current of steam begins to fill the section having a diameter of 17.2 inches, so that there is no free outlet for the mantle of air that is drawn in with and surrounds the inclosed portion of the steam jet. With the nozzle opening located at a still greater distance, the passage of the steam and air will be checked still more, the consequence of which will be that there will be a still greater loss of vacuum by impingement against the side of the funnel-shaped foot and the contraction to which the current will be subjected.

The case of the funnel-shaped stack is somewhat different. Here instead of a nozzle distance of 29.92 inches from the waist in the preceding stack we have a nozzle distance of only 29.92 — 17.52 = 12.4 inches from the smallest cross-section, so that the steam jet has a free entrance into the barrel of the stack, and the entrained air is carried through it unchecked by friction against the sides. It will be at a distance of about $x = (15.75 - 4.74) \times 2.4 = 26.42$ inches that the current of steam would begin to fill the smallest section, as shown in Fig. 57, which corresponds in Plate V. to the abscissa of 26.42 × 17.52 = 43.94 inches. We see, as a matter of fact, that at about 3 feet 7¼ inches measured on the line of the abscissas the line in the diagram curves sharply down

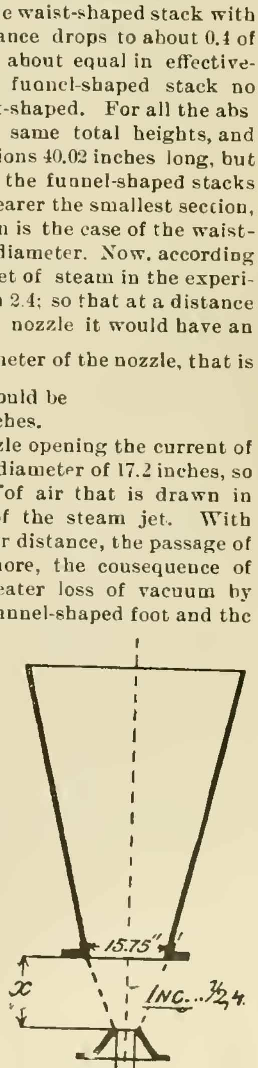


Fig. 57.

*Paper read befo e the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen*.

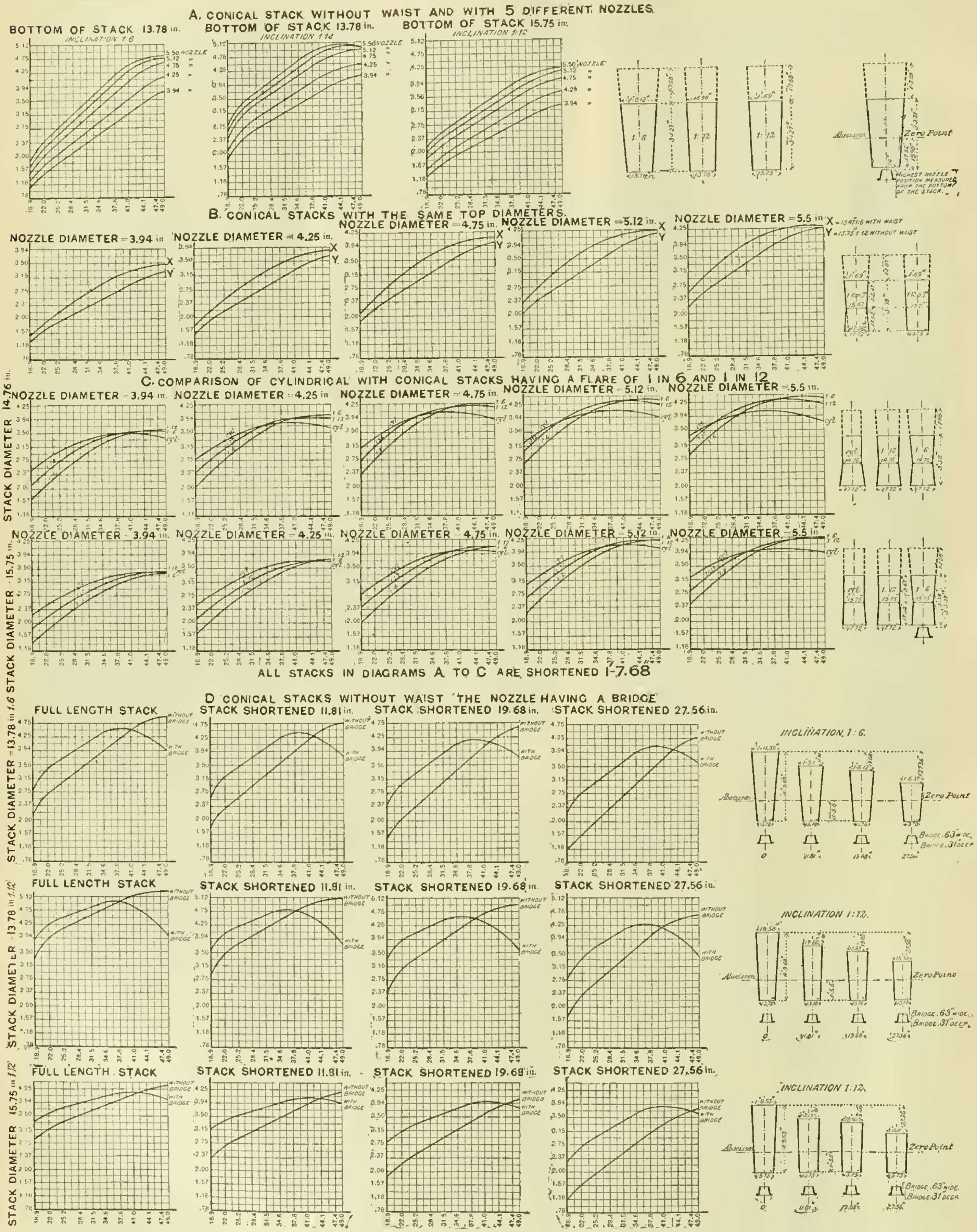


PLATE VI.—DETAIL DIAGRAM OF THE HANOVER SMOKE-STACK AND EXHAUST NOZZLE EXPERIMENTS.

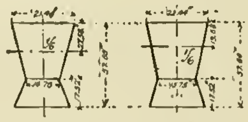
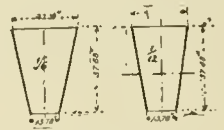
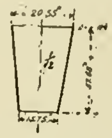
REMARKS.—1. All observations with the water column were made with a constant steam pressure of 3.94 in. of mercury and with the same openings for the admission of air.

2. The abscissas, indicating the nozzle position, are all measnred, on stacks without a waist from a point 17.52 in. above the smallest cross-section, and 18.9 in. above the highest position of the nozzle.

3. In the stacks represented under D, the nozzle without a bridge had an ooening 4.74 in. in diameter, while the one with a bridge had an opening 5.12 in. in diameter; the breadth of the bridge being .63 in. Both nozzles thus had the same free opening.

TABLE XXII.

Comparison of the nozzle positions necessary to produce the same nozzle action (3.94 inches of water), the nozzle distance being measured from the smallest section of the stack, and the nozzle used being with and without a bridge.

Stack.		Nozzle without bridge.	Nozzle with bridge.	Shortening of the nozzle distance due to the use of the bridge.
Diameter and flare.	Length.	Inches.	Inches.	Inches.
14.76 inches (1/6) (With waist)	Full length	6.73	....	6.73 
	Shortened 27.56 inches	25.32	11.14	14.17
15.75 inches (1/6) (With waist)	Full length	13.00	3.74	9.25
	Shortened 19.68 inches	23.43	10.83	12.60
13.78 inches (1/6) (Without waist)	Full length	17.44	10.83	6.61 
	Shortened 11.81 inches	20.28	12.72	7.56
	" 19.68 "	22.32	14.92	7.40
	" 27.56 "	25.00	17.13	7.87
13.78 inches (1/12) (Without waist)	Full length	4.21	1.57	2.64
	Shortened 11.81 inches	9.84	3.15	6.69
	" 19.68 "	14.37	5.12	9.25
	" 27.56 "	19.29	10.43	8.86
15.75 inches (1/12) (Without waist)	Full length	19.02	12.01	7.01 
	Shortened 11.81 inches	23.90	17.13	6.77
	" 19,68 "	28.74	20.87	7.87
	" 27.56 "	(43.90)	(32.87)	(11.02)

REMARKS.—When the stack 15.75 inches in diameter had been shortened 27.56 inches, it became impossible to maintain a vacuum of 3.94 inches any longer. The bracketed figures correspond to a vacuum of 3.51 inches.

in consequence of the reason given, and also of the loss previously shown in Fig. 44. With a stack 13.78 inches in diameter the same thing naturally occurs with a shorter nozzle distance, as shown under *C* in Plate V. The lines also assume the downward curvature earlier and more sharply than with the larger stack.

From these observations and from the conclusion reached above it follows:

That the efficient stack is long and that the nozzle distance should not be too great, say about .3 to .4 of the total height.

Too great a nozzle distance is to be especially avoided, especially on those locomotives hauling heavy trains, which at times work

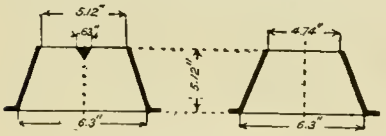


Fig. 58.

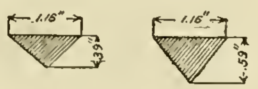


Fig. 59.

slowly and with a late cut-off. In this case the rush of steam receives a decided check, as each exhaust spreads out, after leaving the nozzle, somewhat more sharply than is the case with an uninterrupted current of steam. Therefore if, in such a locomotive, the smallest section is too high above the nozzle, it follows that, under such circumstances the steam does not enter it freely and the entrained air is held back so that the vacuum will be again lowered and the advantage aimed at with the long nozzle distance will be either partially or wholly lost.

VII.—EXPERIMENTS WITH A BRIDGE ACROSS THE NOZZLE.

In the first place, in the latter part of 1891, two four-coupled locomotives with bogie trucks were put in service on the Prussian State Railway, which were at first very poor steamers. An attempt was made to improve them by the use of a wedge-shaped crosspiece, called a bridge, having the sharp edge down.

The result was surprising and brought about a rapid application of the bridge to the large locomotives. The action of the bridge cannot be likened to a similar contraction of the nozzle, for the same thing was accomplished by the introduction of the bridge as is usually obtained in connection with an enlargement of the nozzle. It therefore became necessary to prove the advantage of the bridge on the apparatus to fix the reason for its action and to determine the best form to give it.

In order to shut out, once for all, the plea regarding the contraction of the exhaust nozzle, the same free opening was given to the nozzle with a bridge that the simple nozzle possessed. Fig. 58 shows the form and measurements given to the two nozzles, the breadth of the bridge being 0.63 inch. It was tested with all 18 of the experimental stacks, both full length and repeatedly shortened. The most important result obtained was to show that for stacks of small diameters and short nozzle distances the bridge either made no improvement at all or one that was very slight (see Plate VII., *A*, cylinder stacks having a diameter of 13.78 inches), while for greater distances it acted disadvantageously. It is, therefore, of considerable importance, if the stack is large and not too long and works so much the more, that it should be widened out somewhat at the top. The principal advantage of the bridge is seen to lie in the fact that, for the same amount of work, the necessary nozzle distance can be very considerably shortened. This is especially to be considered in the case of locomotives whose boilers are high, in

FIG. 60.

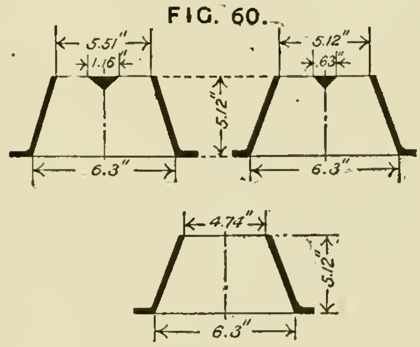


FIG. 61.

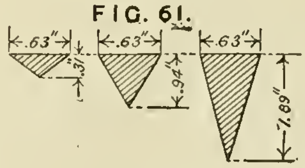
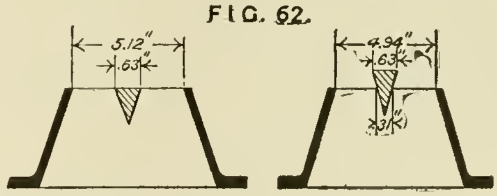


FIG. 62.



which the total height of the stack is comparatively short on account of the other conditions surrounding it.

In order to make this perfectly clear, reference is again made to the diagrams of the experiments with funnel-shaped stacks given in Plate VI. under *D*. Here there are shown the two stacks of 13.78 inches diameter having flares respectively of 1/6 and 1/12 as well as the one of 15.75 inches diameter with a flare of 1/12, each being represented in four different lengths. (It is to be noted here again that 17.52 inches must be taken from the abscissa given in this plate, if we wish to determine the distance of the nozzles from the smallest section of the stack.)

From Plate VI. and VII., it will be seen that a satisfactory action of the bridge is only obtained at certain fixed positions of the nozzle, and that when this distance is increased, the shorter and larger the stack must be made and, above all, the sharper must be the flare. In order that a comparison may be made of this action for various forms of stacks, the figures for several coincal stacks of different diameters and lengths are brought together in Table XXII.

The last column of this table shows very clearly what advantage there is to be gained by the use of the bridge, for it will be seen that in some forms of stack the adjustment of the nozzle position can be shortened 14.17 inches without detracting in any way from the efficiency of the blast. In like manner the action of a locomotive's draft can be considerably increased by the application of the bridge, the position remaining unchanged, and that, too, without contracting the nozzle. If this is not necessary, because the locomotive already makes steam enough, then the stack can be enlarged if a bridge is used. This was practically demonstrated by applications made to six and eight-wheeled engines at the Tempelhof shops. The accompanying Table XXIII.* gives the increase of draft in comparison with an ordinary nozzle, that was obtained on the apparatus with a series of nozzle distances and with different stacks.

We see from this that there are circumstances under which with the same nozzle distance an increase in efficiency of 90 per cent. can be obtained by using a bridge. The most efficient point of action of the bridge of a given diameter, length and sharply contracted stack is also shown.

For the sake of determining the best form, experiments were made with five different bridges. In this work the width was kept the same. First two bridges like those shown in Fig. 59 were tried upon the apparatus ; they had a common width of 1.16 inches, and a depth of .39 and .59 inches respectively on a nozzle with a diameter of 5.51 inches. The free sectional area for the passage of the steam was then exactly the same as that previously used in a nozzle 5.12 inches in diameter with a bridge .63 wide and was also the same as that of a simple nozzle 4.74 inches in diameter, as shown in Fig. 60. In all of these experiments it was clearly shown that the stacks, whether their diameter was greater or less, not only produced a lower vacuum with a bridge 1.16 inches wide, but also threw considerably more water than they did with a narrower bridge and a correspondingly smaller nozzle diameter. The jet of steam was consequently too large for the corresponding sectional area of the stack.

The experiments could, therefore, well be limited to bridges .63 inches wide. They were consequently carried on with three different depths, as shown in Fig. 61. In the lowest, having a depth of .31 inches, the apex was a right angle. The results are shown in Plate VII., under II. In that place only five stacks are given, because the ratios of the bridges to each other, as well as to the other forms of stacks, were exactly alike.

(*To be Continued.*)

*This table we are compelled to omit this month. It will appear in our next issue.—Ed.

New Publications.

THE WISCONSIN ENGINEER. *University of Wisconsin Engineering Journal, Madison, Wis.* Published quarterly; $1.50 per year. Pages $6\frac{3}{4}$ by $9\frac{3}{4}$ inches.

The first issue of this journal is dated June, 1896, and contains 90 pages of interesting and instructive reading matter covering a wide range of subjects. It also contains an index to current engineering periodicals, embracing the period from Dec 5, 1895, to April, 1896, inclusive. This new engineering index is compiled without any description or digest of the articles mentioned in it, and for that reason we think it will be found to fall short of what is usually required. The titles of some articles are a pretty good indication of their contents, while others are very "non-committal" and need an explanatory note or phrase to enable the seeker after information to judge of the value of the article to him. But it may be that we don't know as much as we think we do about what an index ought to be, and we certainly wish the new enterprise all the success to which it aspires. The articles in its reading pages are certainly of a high standard, and if maintained in succeeding issues will place the *Wisconsin Engineer* among the best of the technical periodicals published in connection with engineering colleges.

AIR BRAKE CATECHISM. By C. B. Conger. Ninth Thousand. *Locomotive Engineering.* New York. 96 pages, $3\frac{1}{4}$ by 6 inches. 25 cents.

That there is a demand for this kind of a book is indicated by the fact that the copy before us is one of the ninth thousand that has been published. As suggested by its title, it is written in the form of question and answer, which has some decided advantages in a book of this kind. It is difficult to understand, though, why writers of this kind of "practical" books omit the definite article. Here is an example from the book before us, with hyphens inserted where the article has been omitted. "If (——) train pipe leaks (——) brake will continue to set tighter when (——) brake valve is put on lap, and stop the train before you want it to." There seems to be an idea in some authors of such books that it gives a more distinctly technical character to what they write if the article referred to is omitted.

Some of the engravings in the book are very bad. How any one not familiar with the construction of the engineer's brake valve can learn anything from the smudgy engraving which the publishers have seen fit to put on page 20 any one would be at a less to know. The lettering too in this illustration is very bad. Another fault is that sometimes as many as three separate inquiries are embodied in one of the questions. A novice cannot easily retain these in his mind so as to understand the following answers. The binding of the book is simply infuriating. The leaves are fastened together with wire, and the publishers ought to provide the reader with a small "jemmy" or "pinch-bar" to pry the leaves apart. The index at the end is unworthy of the name, as it gives only 32 terms with the pages in which they are referred to. In a book of this kind a good index is very essential. In speaking of the book generally it cannot be said that lucidity is one of its marked characteristics. A novice, it is thought, will be puzzled a good deal to understand some of the explanations.

Doubtless the book is more susceptible of understanding when used and read on a locomotive or in the shops where the objects explained can constantly be referred to, than it is when such reference is impossible.

WESTINGHOUSE ELECTRIC STREET CAR EQUIPMENTS. *Containing a Description of the Various Motors, Controller and Other Electric Street Car Apparatus Manufactured by the Westinghouse Electric and Manufacturing Company, with Detailed Instructions for the Operation, Inspection and Repair of same; also full Directions for Locating and Remedying Faults.* By Frederick L. Hutchinson and Leo A. Phillips, East Pittsburgh, Pa. 91 pages, $4\frac{3}{4}$ by 7 inches. ($1.)

The sub-title of this book gives a tolerably good idea of its scope and character. In the preface the authors say further that its "object is to give a complete description of the various street-car motors and car equipment apparatus manufactured by the Westinghouse Electric and Manufacturing Company; to give complete directions for the proper inspection and repair of the same; to explain in detail the operations of the various devices, and also to give explicit instructions for locating and remedying any electrical trouble that may be encountered. The writers have endeavored to put all directions, diagrams and illustrations in such form as to be readily understood by any ordinary man, without previous electrical training, and have aimed to give practical rather than theoretical information." The titles of the chapters are "Electrical Units and Terms"; "Description of Westinghouse Street Car Motors"; "Description of Controllers and Other Car Apparatus"; "Operating of the Car Equipment"; "Inspection"; "How to Locate and Remedy Faults"; "Repairs, Rewinding Armatures, etc."

The book is admirably printed, illustrated and bound in limp covers, which invite perusal.

A PRACTICAL HANDBOOK ON THE CARE AND MANAGEMENT OF GAS ENGINES. By G. Lieckfeld, C. E.; authorized translation by G. Richmond, M. E. (with instructions for running oil engines). Spon & Chamberlain, 12 Cortlandt street, New York. 103 pages. ($1.50.)

As the name indicates, this book does not dwell upon the theory of the gas engine, but furnishes the reader with practical information on the purchase, installation and operation of this type of motor. The first chapter is on choosing and installing a gas engine, and tells how to judge the design, workmanship, correctness of running, economy, reliability and durability, etc. The items involved in the first cost of a gas engine installation are enumerated, also the items under the expense of operating. The character of the foundations, arrangements of piping and the precautions to be observed in setting up the engine are also discussed in this chapter. The second chapter is devoted to brakes and their use in ascertaining the power of gas engines. In connection with the work of testing the "brake power" and "indicated power" are defined and compared, and the distribution of heat in the gas engine briefly stated. The third chapter is on the attendance on gas engines, and gives instructions on starting, stopping, oiling, cleaning, etc. The next chapter takes up the different kinds of defects that are liable to develop in operation, and tells what should be done in each case. This chapter is quite complete, and is written in a practical vein, as is all of the book, for that matter. It is followed by a chapter on dangers and precautionary measures in handling gas engines. The last chapter is one of 12 pages on oil engines, and is devoted chiefly to the Hornsby-Akroyd engine. The little book will be found of genuine practical value to those operating gas or oil engines, or about to purchase or install them.

Water-Tube Boilers.*

BY J. WATT.

Some years ago the writer had the honor of reading a paper on the subject of water-tube boilers before the Liverpool Polytechnic Society, and, after enumerating the points which constituted a good water-tube boiler, deduced therefrom the following rules or laws, which should be observed in designing a trustworthy steam generator. They were as follows:

1. The tubes should be arranged in a position to absorb the greatest amount of heat, by causing the flame to travel in an upward direction at right angles to their axis.
2. The tubes should be in a horizontal or inclined position, as the most efficient to emit heat.
3. The steam generated should have free and unobstructed escape to the steam receiver.
4. The circulation or supply of water to the tubes must be copious to prevent overheating.

These are the theoretical, and form the essential, conditions of an efficient water-tube steam boiler.

But, in addition to these, there is another not the less important which concerns the practical part or life of a boiler, namely, the facilities for inspection, cleaning and repairing.

It is 22 years ago since the above was written, and, although old, it is quite as applicable to-day as then, and as far as the writer's experience goes, quite borne out by practice.

It is not the writer's intention of going over the whole range of this subject of water-tube boilers, but to lay before you the result of a few experiments, which may elucidate and explain some of the mysterious circumstances connected with this complex subject.

The experiments were made with a small model boiler (see Figs. 1 and 2) containing 39 straight tubes, each ⅝ inches in diameter by 9 inches long, containing 2.9 square feet of heating surface. The receivers to which the tubes were attached were flat, the end plates were of glass, so that the tubes could be seen right through and the action going on inside could be distintly observed. A steam receiver was also placed on the top, connecting the two other receivers. Heat was supplied by two Bunsen burners, consisting of two tubes with cross slots, the heating taking place being very much similar to that of an ordinary firegrate burner. The model was so constructed that it could be used or tried in a great number of different positions.

The first series of experiments was made with a view of finding out the relative value of heating surface when the tubes were angled from a horizontal position gradually to that of a vertical one, or through an angle of 90 degrees. The experiments were conducted at atmospheric pressure, and commenced by first raising a

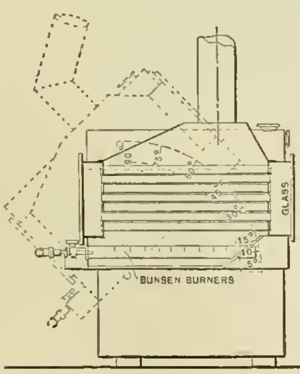


Fig. 1.

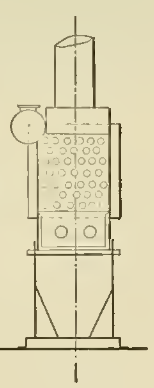


Fig. 2.

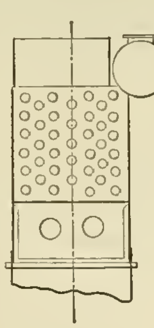


Fig. 3a.

given weight of water to the boiling point, and then ascertaining the amount evaporated after an interval of 15 minutes.

After a few preliminary trials, it was found that when the boiler was angled about 10 degrees from the horizontal the evaporation was highest, viz., 8½ ounces; when the angle was increased to 15 degrees, the evaporation was 8¼ ounces; 30 degrees, 7½ ounces, 45 degrees, 6½ ounces; 60 degrees, 5¾ ounces; 75 degrees, 5½ ounces; and 90 degrees, 5 ounces. Again on reducing the angle to 5 degrees, the evaporation was 8¼ ounces, and when level 7½ ounces. It may be here stated that owing to the pressure of gas varying a little, very seldom the same results could exactly be arrived at, but by making several trials the above is a fair average. This is graphically represented in Fig. 3 (top curve); the vertical ordinates representing the percentage of evaporation at the various angles at which the boiler was tried beginning at the horizontal position and gradually rising to the vertical position. It was found when the boiler was angled 10 degrees it gave the best result; therefore 10 degrees represents the maximum evaporation, or 100 per cent.

In looking at this diagram, we find that in any water-tube boiler whose tubes are inclined, say 10 degrees, by merely increasing the angle to 30 degrees the amount of water evaporated is reduced from 100 to 85, or 15 per cent. less. If the angle be increased to 60 degrees the decrease will be 33 per cent; and at 90 degrees, or the tubes vertical, the reduction is a little over 40 per cent. This compares very favorably with the old-fashioned rule employed in the ordinary steam boiler of allowing 2 square feet of vertical heating surface to be of equal value to each 1 of horizontal.

These experiments were conducted with the tubes placed in horizontal rows, so as to allow the products of combustion to travel in a zigzag direction to the funnel. The next series were taken with the boiler turned on its side, so as to form the tubes into vertical

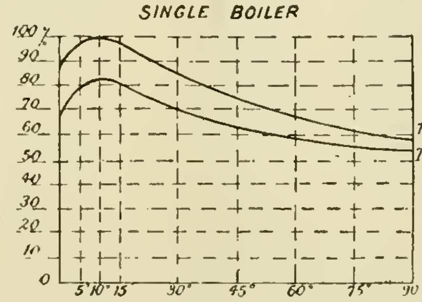


Fig. 3.

rows, and giving the products of combustion a more direct course to the funnel (see Fig. 3a). The result is shown by the lower curve on Fig. 3. The highest percentage was 82 per cent. at 10 degrees and 53 per cent. at 90 degrees, the best result showing a difference of 18 per cent. in favor of the former arrangement of tubes.

Instructive as these tests may be, the next series will show still more striking results. In order to arrive at the duty performed by various tubes or rows of tubes, and more especially those nearest to the source of heat, if we take another boiler—or, rather, a part of a boiler representing that row of tubes which is nearest to the fire—and place the two together, as represented in Fig. 4, we have the means of arriving at the evaporation of each boiler separately. This small boiler consists of six tubes only, having a heating surface of .44 square feet, compared with the larger one of 2.9 square feet, or a combined heating surface of 3.34 square feet.

The results of this arrangement are represented on diagram Fig. 5. The upper curve shows the combined evaporation of both boilers, and although there is an augmented heating surface of about 15 per cent., yet there is very little difference in the amount evaporated. The lower curve shows the evaporation of the original or larger boiler, and we now see that at its best it is reduced from 100 per cent. to 40 per cent, at 10 degrees, and from 60 per cent. to 17 per cent. at 90 degrees. On the other hand, the small boiler is represented by the middle curve, and its evaporation at its best is 60 per cent. at 10 degrees, and 45 per cent. at 90 degrees. The above results may be stated in other words, namely, that practically 60 per cent. of all the steam generated in any water-tube boiler with tubes at any angle is generated in the first or nearest row of tubes to the fire. The remaining 40 per cent. is left for the larger portion of the boiler to accomplish.

By reversing the positions of the two boilers—by placing the smaller on top of the larger one—we can arrive at the evaporation of the top row; but this was found to be so small as not to be taken notice of. The writer had not the means of testing the intermediate rows; but the following table will not be very far off:

1st	row	nearest	to	the fire	evaporated	60.0	p. c. of	the total	evaporation.
2d	"	"	"	"	"	24.0	"	"	"
3d	"	"	"	"	"	9.5	"	"	"
4th	"	"	"	"	"	3.5	"	"	"
5th	"	"	"	"	"	1.5	"	"	"
6th	"	"	"	"	"	1.0	"	"	"
7th	"	"	"	"	"	0.5	"	"	"
						100.0			

The importance of the above cannot be overlooked. Either the first row is doing too much, or the back row too little; and the conclusion arrived at is that, practically, the first row is receiving the whole wear and tear of the boiler, therefore more

* From a paper read before the (British) Institution of Naval Architects, March 26, 1896.

liable to damage and renewals. This has proved itself in the case of copper tubes, which, although a better conductor of heat than either iron or steel, yet were unable to stand the severe work they had to perform. The danger from overheating and rupture is not only very unpleasant from a stokehole point of view, but the giving way at some critical moment demands our most important consideration; in short, it is the vital part of the water-tube boiler.

Seeing this difficulty some time ago, the writer devised some means by which the first row was relieved of this heavy duty, and more laid on those immediately behind. This is accomplished by substituting tubes of much larger diameter nearest to the fire than those which are more remote. The larger tubes contain more water, and present less heating surface for the space occupied than those of smaller diameter. The result is that the evaporation is less

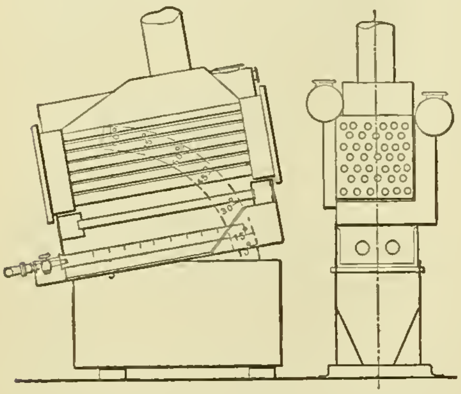


Fig. 4.

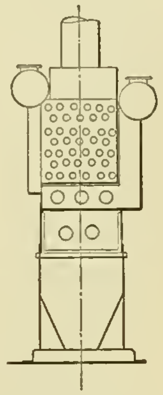


Fig. 6.

with the larger tubes, but greater with the smaller. Fig. 6 represents the arrangement. For the six ⅝-inch tubes we now adopt three 1¾-inch tubes in their place. The weight of water in the three tubes is double that in the six smaller ones, while the heating surface remains the same. The diagram representing the results of the trials is shown on Fig. 7, the top curve, as before, representing the results of the two boilers. Practically there is very little difference compared with the similar top curves of Figs. 3 and 5; if anything, it is slightly in favor of Fig. 7. But when we come to compare the two lower curves with the similar curves in Fig. 5, we find that they have almost changed places. Taking the top or larger boiler, the evaporation at 10 degrees is nearly 60 per cent. of the total, as compared with a little over 40 per cent. shown on the former trial, the curve dropping down at 90 degrees to 27 per cent., against 17 per cent. Taking the lower boiler, repre-

COMBINED BOILER WITH SMALL BOTTOM TUBES

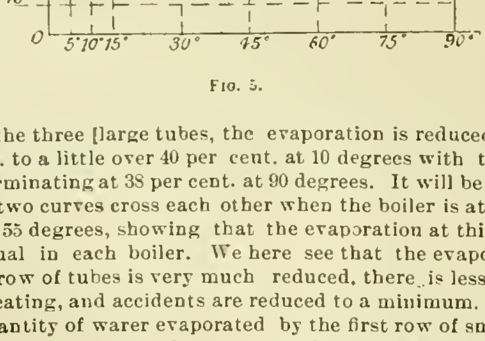


Fig. 5.

senting the three large tubes, the evaporation is reduced from 60 per cent. to a little over 40 per cent. at 10 degrees with the larger tubes, terminating at 38 per cent. at 90 degrees. It will be observed that the two curves cross each other when the boiler is at an angle of about 55 degrees, showing that the evaporation at this angle is about equal in each boiler. We here see that the evaporation in the first row of tubes is very much reduced, there is less liability to overheating, and accidents are reduced to a minimum.

The quantity of warer evaporated by the first row of small tubes was at the rate of 5 pounds per square foot of heating surface per hour, and the velocity at the end of the tubes about 3.8 feet per second. The tubes were full of semi-steam and water, so that no

COMBINED BOILER WITH LARGE BOTTOM TUBES

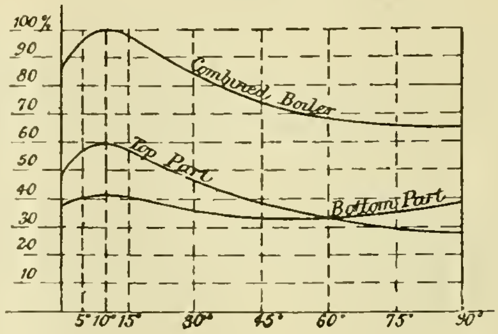


Fig. 7

light could be seen at the other end; evidently these tubes were evaporating their maximum quantity with efficiency.

On the other hand, with the row of large bottom tubes, the rate of evaporation was about 3.5 pounds per square foot heating surface, and the velocity at the tube ends (steam only) about 2.9 feet per second. Up to an angle of about 60 degrees a light could be distinctly seen through these tubes, the steam occupying about one-third of the area on the top side, the water undearneath presenting a clear, solid mass. Above 60 degrees elevation the water and steam became more or less mixed up, so that a light could not be seen at the other end.

It must be remembered that the above trials were made at a pressure of 1 atmosphere where the relative volumes of steam and water are as 1,640 to 1. For higher pressures a corresponding rate of combustion may be adopted.

The most vital parts in any water-tube boiler, and the most easily damaged by overheating, are those tubes in close proximity to the fire. To overcome this difficulty two courses are open—(*a*) by adopting small tubes and providing for a vigorous circulation; (*b*) by adopting larger tubes and a less active circulation. Adopting the former, there is a limit both in respect to the speed of the current and the quantity of steam in contact with the heating surfaces. According to Mr. Thornycroft's experiments, at a pressure of 3 atmospheres the relative volume of steam and water passing through a number of 1⅛-inch tubes was about 5.4 to 1, and at 12 atmospheres this would equal 1½ to 1, or three volumes of steam, at an average, in each tube, to two of water, a condition of things which presents to us two evils; one is the danger arising from the tube becoming much hotter than the temperature due to the pressure. As an instance of this, there is the failure of copper tubes in water-tube boilers to stand this excessive heat. The second evil is the slow corrosion taking place, owing to part of the steam in contact with the tube becoming decomposed at a high temperature, forming oxide of iron and hydrogen gas. By the improved arrangement of larger tubes to face the first and direct action of the fire, a larger body of more solid water is in actual contact with the heating surfaces; the liability to damage by overheating is reduced to a minimum; the duty of the various tubes more evenly distributed, and the steam generated more freely disengaged.

In conclusion, there is one point which, during the time these experiments were being made, confirmed the writer's views more strongly of a grave defect in Belleville water-tube boilers for marine purposes.

The arrangement of all water-tube boilers with horizontal or slightly inclined tubes, on board ship, should be parallel with the line of keel. But it appears to be the rule, so far as this boiler in question is concerned, to place the same across the ship. Now, the inclination or angle of the Belleville boiler tubes is about 2 degrees or 3 degrees from the horizontal, and as 10 degrees, say, is not an uncommon angle for a ship to roll at sea, it follows that the tubes will become depressed, or angle reversed, to the extent of 7 degrees or 8 degrees.

A ship to roll from eight to ten rolls per minute is not uncommon, and therefore six or eight seconds would be the duration of one roll.

Now, imagine the ship rolling, a heavy fire on the grate, and in this time these lower tubes, generating, as we have seen, such a large volume of steam, which would immediately reverse the circulating current, fill the upper ends, and be here imprisoned, only to be relieved by the next roll. The greater portion of the steam will now be transferred to the other end, to be again reimprisoned, and so on until the ship gets into lest turbulent waters. With reference to what the continued effect on these semi-dry tubes would be in a sea way, or in the event of the ship having a list, the result is left for your better and impartial judgment.

The Eighth Statistical Report of the Interstate Commerce Commission.

The advance sheets of the eighth statistical report of the Interstate Commerce Commission have been received. Although hoary with age, relating as they do to the year from July 1, 1894, to June 30, 1895, we will follow the custom of quoting a few of the figures.

On June 30, 1895, 169 roads, operating 37,855 miles of track, were in the hands of receivers, 23 roads and 2,963 miles less than 12 months previous. The total mileage in the United States on that date was 180,657.47 miles. During the year covered by the report 14 roads were abandoned, 9 merged, 32 re-organized, and 28 consolidated. There was on June 30, 1895, 1,965 railway corporations of which 1,013 maintained operating accounts. The total number of locomotives in service were 35,699. Of this number 9,999 were passenger locomotives, 20,012 freight locomotives, 5,100 switching locomotives and the remainder unclassified.

The total number of cars reported was 1,270,561, of which 33,112 were passenger ears, 1,196,119 were freight cars, and 41,330 were used by the roads in their own service. These figures do not include private car-line equipment. The number of passengers carried per passenger locomotive was 50,747, or 3,907 less than in 1894. The number of passenger-miles per passenger locomotive was 1,218,967, or 225,433 less than in 1894, while the number of passenger cars per 1,000,000 passengers carried was 65, or 12 greater than the preceding year. This is probably largely due to decreased travel on account of business depression, but it also suggests that passenger traffic has returned to its normal condition previous to the World's Columbian Exposition. The number of tons of freight carried per freight locomotive in 1895 was 34,817, showing an increase of 2,908 when compared with the corresponding figures for 1894. The number of ton-miles per freight locomotive was 4,258,821, the increase over the previous year being 242,066. These figures indicate increased economy in transportation of freight. The same result is shown by the fact that 1,888 freight cars were required to move 1,000,000 tons of freight in 1894, and 1,717 in 1895. These figures, however, are not satisfactory, because the basis of the computations does not include cars not owned by railway companies, in which a large proportion of freight is transported.

Out of a total equipment of 1,306,260 locomotives and cars, only 362,498 were fitted with train brakes, and 408,856 with automatic couplers on June 30, 1895. The increase in equipment fitted with train brakes was 31,506; with automatic couplers, 51,235. On June 30, 1895, the number of passenger cars in service was 33,112, of which 32,384 were fitted with train brakes, and 31,971 with automatic couplers. The number of freight cars in service was 1,196,119, of which 295,073 were fitted with train brakes and 366,985 with automatic couplers.

The number of men employed by railways shows an increase of of 5,426, as compared with last year, the number of employees being 785,034 on June 30, 1895.

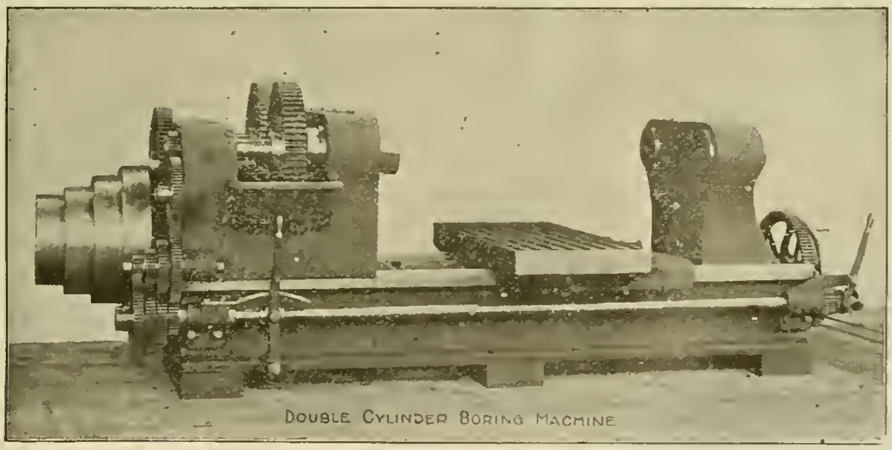
The number of passengers carried by the railways during the year ending June 30, 1895, was 507,421,362. The number of passengers reported as carried one mile was 12,188,456,271. The number of tons of freight carried as reported by railways was 696,761,171. The number of tons carried one mile was returned as 85,227,515,891, indicating an increase of 4,892,411,189.

The gross earnings of the railways for the year ending June 30, 1895, were $1,075,371,462. The expenses of operation for the same period were $725,720,415, which were $5,693,907 less than for 1894. The important unit in railway statistics designated as the coefficient of operating expenses, that is, the percentage of operating expenses to operating income, for 1895, was 67.48 per cent. The amount of railway capital on June 30, 1895, is shown to be $10,985,-203,125, or $63,330 per mile of line. The increase during the year was $188,729,312.

The number of railway employees killed during the year was 1,811, and the number injured was 25,696. The number of passengers killed was 170, the number injured, 2,375. One employee was killed for each 433 employed, and one employee was injured for each 31 employed. Of the class of employees known as trainmen, that is, engineers, firemen, conductors and other employees whose service is upon trains, it appears that one was killed for each 155 in service, and one injured for each 11 in service. The number of passengers carried for each passenger killed during the year was 2,984,832, and the number carried for each passenger injured was 213,651. The liability of passengers to accidents is better shown in the fact that 71,696,743 passenger-miles were accomplished for every passenger killed, and 5,131,977 passenger-miles for every passenger injured.

Double Cylinder Boring Machine.

The machine shown herewith is designed for rapidly boring two cylinders at once. It is peculiarly useful in works where a large number of cylinders of the same or nearly the same size are to be bored. The machine is usually made with a bed 11⅓ feet long, fitted with a head stock carrying two heavy spindles 5 inches to 9 inches in diameter with bearings adjustable for wear, placed with their centers 31 inches apart horizontally. These spindles are driven by a 30-inch cone pulley with four steps for 3-inch belt, geared 15 times. The boring bars are inserted in these spindles and have their outer ends supported in a double tail stock fitted with removable bushings and adjustable upon the bed.



Double Cylinder Boring Machine.

The work table is 66 inches by 43 inches, which dimensions, however, can be varied when required. The table traverses by hand or power, 45 inches upon the bed. It has four automatic feeds ranging from $\frac{1}{32}$ to ¼ of an inch. These feeds can be changed at slight expense to any desired figures, and the bed can be lengthened or shortened within reasonable limits, to suit requirements. From the top of the table to the center of the spindles is 18 inches, and the bed is 5 inches below the top of the table. The total swing over the bed is 48 inches, and over the table 38 inches.

This special machine has been designed by Messrs. Bement, Miles & Company, of Philadelphia. It is particularly useful in shops where large numbers of small cylinders are being manufactured. One of these machines has lately been installed in shops where they are manufacturing air compressors, rock drills and similar work. It has proven in this connection very efficient and satisfactory.

A New Dynamometer.

Consul Doederlein, of Leipsic, calls attention to a new dynamometer invented by Mr. von Pittler, in Germany. This dynamometer, so it is claimed, is of equal value as an instrument for power lessors and power lessees. The construction is extremely simple, as all delicate parts are excluded. It is available as an independent apparatus for the measurement of power, either of individual machines or of a whole establishment. It can, furthermore, be used as an intermediate countershaft, and is, as such, in addition to its qualities as a dynamometer, an excellent elastic impulsion, especially for electric motors.

Just in the same way as this dynamometer can be used as a countershaft, it can also be connected with the shafting. The actual cost is so low that we must regard it, on account of its good qualities, as a necessary part of a shafting—as a part that everybody in possession of a mechanical motive power must of necessity have, if he desires to utilize such power to advantage. The dynamometer can be easily handled and controlled by anybody, whether expert or layman.

The consumption of motive force, be it fuel (in the shape of coal, steam, hot air, oil, etc.), water power or electricity, can be controlled per absorbed power unit, so that both power lessor and power lessee can check off the consumption of power at any time, say weekly, monthly or yearly, in the most precise manner.

It has also been observed by Mr. von Pittler, by means of his apparatus, that the amount of labor performed in his factory each day from 7 to 9 o'clock a. m. was proportionately less than from 9 to 12 o'clock a. m. It was found that this difference was due to the fact that the foreman came to the factory at 9 o'clock. Again, the record kept by Mr. von Pittler shows that the amount of labor on Fridays, Saturdays and Mondays was 800,000 meter kilograms less than other days, whereas on Thursday—the day before pay day—the largest amount of labor was performed.

Mr. von Pittler, who has the counting apparatus adjusted to one side of his office desk, thereby keeping control over the work of his machines, can also very easily ascertain the difference in the amount of coal used before and after cleaning the boilers.—*U. S. Consular Notes.*

The Origin of the Word Derrick.

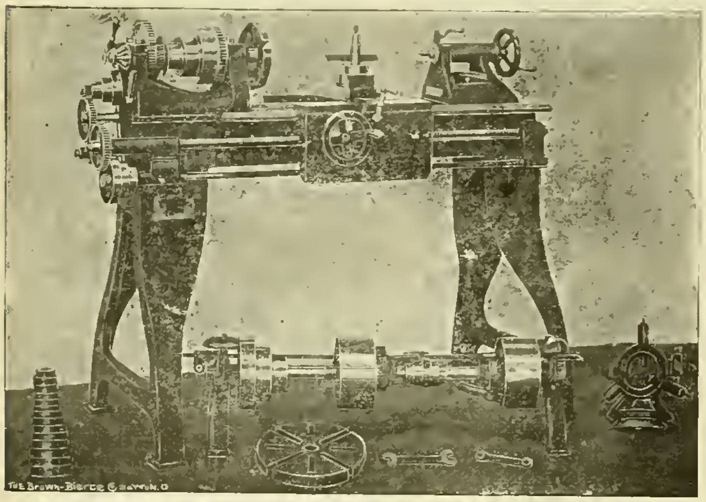
How many mechanics or engineers have ever heard how this word originated? The following is taken from an "exchange":

"In mechanical matters the name of the familiar "derrick," a very common form of crane, has not the most honorable pedigree. Derrick was indeed nothing more exalted than the Tyburn hangman of the early part of the seventeenth century, and his name figures frequently in plays of the period. For more than a hundred years he gave his name to gibbets, whose "elevating" powers were applied in a more useful direction in the modern "derrick."

Webster says the word originally meant a gallows, from a hangman named *Derrick*.

The Wagner 12-Inch Lathe.

The accompanying illustration is of a 12-inch lathe built by the A. P. Wagner Tool Works, Sidney, O. This firm build a line of lathes similar to this one in sizes from 8 to 18 inches. They are strong and well built, and the makers claim they are second to



12-in. x $4\frac{1}{2}$-ft. Bed Screw and Rod Feed Lathe with Three-Speed Cone.

none in the market. The head stocks and tail stocks are not cored out at all, but are solid. The spindles are of the best hammered steel, accurately ground, and they run in phosphor bronze bearings. The reverse and cone gear are cut out of solid steel. The carriage is gibbed front and back and has extra large bearings its entire length, and is arranged for side facing. All sliding parts are accurately scraped to a bearing. The 12-inch lathes are furnished complete with steady rest, large and small face plates, centers finished drop-forged, and a full set of standard change gear; also with a plain rest, a compound rest, plain foot power or bicycle foot power, friction countershaft or plain countershaft. Some of the important dimensions of the 12-inch lathe are as follows:

Swings over bed	13 inches
Swings over carriage	$8\frac{5}{8}$ inches
Swings over plain or compound rest	$7\frac{7}{8}$ inches
Diameter of three-speed cone	$6\frac{1}{2}$, $4\frac{3}{4}$, 3 inches
Diameter of four-speed cone	$6\frac{3}{4}$, $9\frac{1}{2}$, $4\frac{1}{2}$, 3 inches
Width of belt on cones	2 inches
Diameter of head spindle	$1\frac{11}{16}$ inches
Hole through spindle (standard)	$\frac{11}{16}$ inches
Front bearing of spindle	$1\frac{11}{16}$ by $3\frac{7}{8}$ inches
Back bearing of spindle	$1\frac{7}{16}$ by $2\frac{1}{2}$ inches
Diameter of tail spindle	$1\frac{6}{16}$ inches
Will cut screws	2 to 40 threads per inch
Will cut pipe threads	$11\frac{1}{2}$ threads per inch
Speed of countershaft	180 revolutions
Size of countershaft pulleys	8 by 4 inches
$4\frac{1}{2}$-foot lathe takes between centers	24 inches
Weight of $4\frac{1}{2}$-foot lathe for domestic shipment, about	1,050 pounds
Weight of $4\frac{1}{2}$-foot lathe for foreign shipment, about	1,450 pounds
Beds made in lengths of	$4\frac{1}{2}$, $5\frac{1}{2}$, $6\frac{1}{2}$ feet

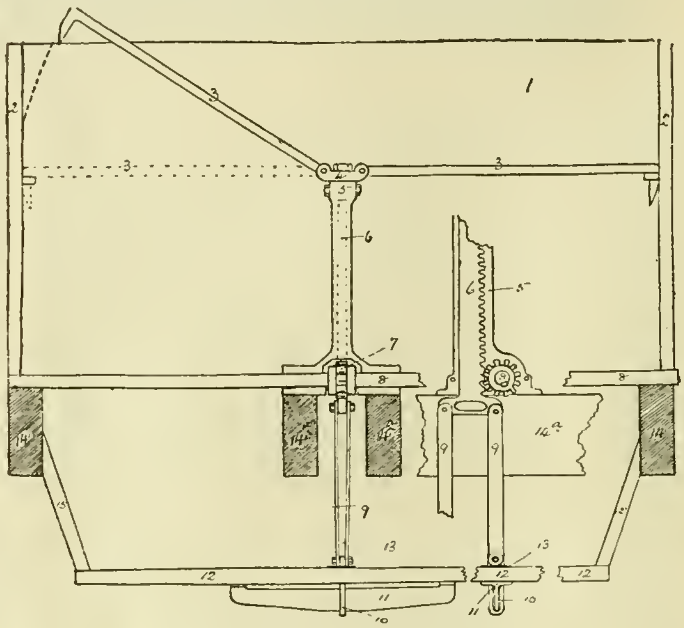
This company has an entirely new plant heated by steam and lighted by its own electric-light plant. All its machinery is modern, and the excellent facilities are supplemented by a rigid inspection of all work. The concern also builds a full line of plain and automatic turret lathes.

Its new catalogue, just issued, is printed in English, German, Spanish and French, and will be sent on application. The orders this company has received for its machines are so numerous that it is running its works double time.

The Fader Dump Car.

The Fader device for operating the drop doors of a hopper-bottom car is shown in the accompanying drawing. It can be readily fitted to any ordinary hopper-bottom car without material alteration of the car. The chains by which the doors are usually operated being removed from the shaft, a small cast-steel toothed-pinion is keyed to it in the center, between the center sills of the car; against this, traveling vertically between the sills is a cast-steel toothed-rack, to the lower end of which are attached parallel links of such a length as just to touch the inner face of the doors when closed. Along the outer face of the two doors are two cross-bars of flat bar-iron, about one-half of the length of the doors, and supporting the latter at their extreme ends; passing through the doors are two links which pass around these cross-bars and connect them with the lower ends of the longer links. By this arrangement the weight of the doors and the load is at twice as many points as would be the case if the links were directly connected to the doors.

Fitting over the rack and pinion and acting both as guide and stop to the former is a case of malleable iron bolted to the sills of the car. This case is made in halves, so that either part may easily be removed when necessary.



Fader's Dump Car Mechanism.

1. End of car.
2. Sides of car.
3. Cross binders.
4. Swivel.
5. Rack-case.
6. Rack.
7. Pinion.
8. Shaft.
9. Links.
10. Connecting links.
11. Cross bars.
12. Drop-doors.
13. Washer plates.
14. Outer sills.
14a. Center sills.
15. Sides of hopper.

At the top of the rack-case is the square head of a bolt to which is fastened a swivel with two long wrought-iron cross-binders (or arms with hooked ends) hinged to it, designed to engage in eyes fixed to the inner surface of the sides of the cars, to prevent their bulging when loaded with coal or material of a like nature. When the car is loaded with lumber, or any material not liable to cause bulging, the cross-binders may be unhooked, the swivel turned round longitudinally in the cars and the arms thrown upright across one another (for which purpose they are each provided with a slight off-set), or they may be allowed to hang down between the twin longitudinals; in either case they are well out of the way and occupy but little space in the car. The ratchet and pawl and wrench now in use may still be utilized.

Some of the special features claimed for the car are: 1. Though the power is applied centrally the weight of the doors is divided equally between two points at or nearly opposite the hinges. 2. In case of the doors being jammed or frozen together it is possible to force them down from the interior, the downward movement of the rack transmitting a similar movement to the bar-links which rest on the inner surface of the doors. 3. The removable cross binders supply the advantage of fixed cross-beams without being in the way when the cars are required to be loaded with lumber and other material necessitating the use of the full length of the car. 4. The rack and pinion are well protected from dust or anything that might in any way impair the efficient working of the device; none of the working parts are exposed, and they are not, therefore, liable to get out of order.

Further information is obtainable from M. E. Bourne, Vancouver, B. C.

The Franklin Institute has awarded the Pantasote Leather Company, of New York, the Edward Longstreth Medal of Merit for the excellence of "pantasote" as a substitute for leather in many of its uses.

It is stated that the new gas engine, upon which experts in the employ of Mr. Westinghouse have been working, is now about perfected and its manufacture will be pushed by the Westinghouse Machine Company.

The Buffalo, Rochester & Pittsburg will erect at Du Bois, Pa., new car shops consisting of a mill building 60 by 200 feet; engine house, 60 by 125 feet; blacksmith and machine shop, 40 by 50 feet; storehouse, 48 by 80 feet, and paint shop, 24 by 96 feet.

The Pittsburgh Reduction Company, of Pittsburgh, Pa., recently rolled some aluminum plates 94 by 94 inches, for the United States government. One of the sheets after rolling was 150 by 100¼ inches, which is said to be the largest sheet of aluminum ever rolled.

The Stilwell-Bierce & Smith-Vaile Company, of Dayton, O., has closed a contract, amounting to nearly one half a million with a Montreal company for water wheels. It includes 34 wheels, and 21,000 horse power generated is to be conveyed electrically to Montreal.

An attempt is being made to reorganize the Rhode Island Locomotive Works, of Providence, R. I., which closed down last month for an indefinite period. The concern has been for some time in the hands of a committee of the creditors. The contracts which the company had are completed and the committee ordered the shut-down.

The Carnegie Steel Company have placed with the Westinghouse Electric and Manufacturing Company an order for a complete electrical equipment for the Duquesne works. Power will be supplied for all light cranes, etc. There will be 16 large dynamos at the start and the installation will be so made as to permit of adding to it readily.

The Westinghouse Electric and Manufacturing Company has received a contract from the Baltimore, Cantonsville & Ellicott City Railway Company for 32 100-horse-power and 20 30-horse power electric motors for its new railway. The heavy motors will be used between Baltimore and Washington and the smaller ones for shorter runs.

The Brown Hoisting and Conveying Machine Company, of Cleveland, O., have received an order from Fried, Krupp, at Essen, Germany, for a complete hoisting and conveying plant for its blast furnace at Rheinhausen. This plant consists of three electrically operated Brown overhead bridge tramways, each machine having independent winding drums and motors. The company is to furnish all the working parts, including everything but the bridges proper, which will be built in Germany.

The Babcock & Wilcox Company write us as follows: "It having come to our notice that various parties are offering to build what purports to be Babcock & Wilcox boilers, we wish to notify all whom it may concern that no outside concern has been authorized to build our boilers. Without infringing a large number of patents owned by us no one can build other than a very antiquated form of Babcock & Wilcox boilers, and buyers are warned to be on their guard in dealing with anyone who offers them."

Mr. Quayle, Superintendent Motive Power of the C. & N. W. Railroad, expresses himself as being well pleased with the Salt Mountain asbestos as a lagging for his locomotive boilers. Having used it for a year with the best results as far as shown, he is now using it in its natural state for packing around cylinders and steam chests and in other places on his locomotives to prevent radiation of heat and condensation of steam. He is also making quite extensive use of it for stationary work.

Last month H. K. Porter & Company, of Pittsburgh, received orders for engines from foreign companies amounting to between $30,000 and $40,000. One of these engines is for a Russian railroad near St. Petersburg, where the engine is to compete with German engines. The engine will have a gage of but 29½ inches. A standard locomotive has also been ordered for San Salvador, Central America, and one is being built to haul asphalt at Trinidad, in the West Indies. A 30-gage engine is being built for a tramway at Port au Prince, Hayti, and two 40 ton locomotives are being constructed for use in the gold mines in South Africa, near Johannesburg. An experimental engine will also be built for use in Tiflis, in the Caucasus Mountains.

The electric locomotive exhibited by the General Electrical Company at the Chicago Exposition in 1893, which had a rated drawbar-pull of 7,000 pounds, has been purchased by the Manufacturers' Street Railway Company of New Haven, Conn. It is equipped with air-brakes and its total weight is 30 tons. It will be used to haul freight cars from the junction of the New York, New Haven & Hartford Railway at Cedar Hill, which is about one mile from the New Haven passenger depot, to the works of numerous manufacturing establishments located along the water front at some distance from the freight yards of the "Consolidated" road. The length of the line along which this locomtive will run is nearly two miles, the maximum grade being about 2½ per cent.

Mr. Willis Shaw, 506 New York Life Building, Chicago, Ill., has just issued a catalogue of second-hand machinery of various kinds, which he has for sale and which are ready for prompt shipment. There are 20 pages in the catalogue and the machinery listed includes air compressors, air receivers, blowers, boilers, suspension cableways, contractors' dump cars, stone cars, channeling machines, hoists, derricks, ditching machines, drills, dredges, engines of various kinds, locomotives, ore crushers, pile drivers, cast-iron and steel pipe, contractors' plows, pumps and pulsometers, rails, road rollers and many others. All this machinery is stated to be in good condition and ready for service. Most of it is comparatively new and may be inspected in Chicago. Mr. Shaw is also ready to furnish new equipments. Copies of the list or catalogue will be sent on application.

The Monash-Younker Company, 203 South Canal Street, Chicago, Ill., has lately been incorporated for the manufacturing of steam and water specialties. The new company owns and controls all the specialties manufactured by the Van Auken Steam Specialty Company (mentioned several times in these columns), who will continue to manufacture their specialties, but those goods will be sold through the new concern, the Monash-Younker Company. This new company has also purchased the patent and plant of the Star Coupler Company, of St. Louis, and will manufacture Star lead pipe couplers and fittings for lead pipe plumbing without soldering or wiping a joint. Parties interested in high grade steam specialties or the new method of doing lead pipe plumbing without soldering or wiping joints should address The Monash-Younker Company for their catalogue and mention this journal.

Quite in contrast with the general dullness is the unusual activity displayed at the works of the Link Belt Machinery Company, Chicago, who have been operating their machine shop with two gangs of men both day and night during the past three months. The foundry is also being worked to its limit, one order for castings alone requiring 987,000 pounds of iron. A notable order is that for furnishing the Chicago Sugar Refinery with a complete equipment of machinery for handling coal from cars to iron bins located over 25 Babcock & Wilcox boilers in the power-house. From these bins, whose storage capacity is 650 tons, the coal is spouted directly on to chain grates under the boilers. An order for the Huron Iron Company, Michigan, for two 8-foot, spirally grooved hoisting drums, together with a 11½-inch by 25-foot shaft, friction clutches, base plates, etc., and brake bands for running the drums independent of each other, both for hoisting and lowering, is nearing completion. The two friction clutches and brake bands are so arranged that they can be operated by one man without moving from one place to another, the operating mechanism being brought to the center of the frame.

The Westinghouse Electric and the Baldwin companies are to build a 75-ton electric locomotive for the Wheless system of electric roads. This system comprises an underground conductor, a series of buttons projecting slightly above the surface of the pavement between the tracks, and electro-magnetic switches to energize the buttons as the car passes over them. The electricity is taken from the buttons by long collecting bars suspended under the car. To start the car a current from a battery is sent through the collector bars and the buttons in contact with them. This current passes through a magnet in the switchbox under the buttons and raises an armature and brings into contact two sets of carbon discs. The current from the underground feeder wire now passes through the carbon contacts and thence through a coarse coil on the magnet, thereby assisting in holding the switch closed, and thence to the motors by means of the positive contact button and the corresponding collecting bar. From the motors the current passes to the rails or ground as usual. As the car advances the two collecting bars come into contact with the next group of buttons and the process is continually repeated. As the bars leave a set of contact buttons that particular circuit is open, the magnet armature falls by gravity, thus opening the switch and disconnecting the feeder from the positive button. Thus al the buttons are "dead" excepting those directly under the car. This is the system which the Westinghouse Company has adopted and on which so much practical experiment has been lavished.

The new large works of the Q & C Company, manufacturers of railway supplies and special machinery, which has recently been erected at Chicago Heights, a suburb of Chicago, is kept quite busy on orders for the well-known goods made by this company. They have recently secured orders for six large metal sawing machines, a number of which will carry saw blades 36 inches in diameter, and all but one of these machines are to be run by electric motors. The Bryant patent metal saw, as manufactured by this company, requires such a small amount of power to operate successfully that there is a growing demand for these machines equipped with motors, as the saving in actual cost for operation is considerable, at the same time giving equally efficient results. In addition to orders being received for their metal sewing machines, there is no lack of business in their railway equipment and tieplate departments. The output of the Servis tie plate alone this year will aggregate many millions.

The company is constantly receiving testimonials to the excellence of their sawing machines. One party says: "We now have in our works one No. 10 and one XX Bryant Sawing Machine. Our Superintendent is highly pleased with both. They do good work, they do a good deal of work, and do it very nicely, and do not require a skilled workman to operate them." Another says: "Have had one of your No. 10 Sawing Machines since April, 1892, and an XX Cold Saw for nearly two years. Both machines are in almost constant use and are giving us entire satisfaction." A third party says: "I have had it in use continually for nine months with the exception of intervals of a few days. I can cut a 70-pound steel rail in from 12 to 13 minutes, and have made cuts from ½ inch upward. I have had it in constant use for one and one-half days at a time before getting saw sharpened." Still another writes: "I secured this machine some two years ago and have not bought a set of crossings for renewals since. I usually make card template of the angular joint to be renewed and have it sawed and drilled at my supply yard or let foreman do it on the ground. I consider this saw the best money saving appliance I have on my division. The average time required to cut, say an angle of 45 degrees, is about 20 minutes."

New England Resorts via the Boston & Maine Railroad.

To travel is a pleasant and profitable diversion, and New England, with its widely varying interests, is a region through which one may tour indefinitely, and no matter which way you tour pleasing and interesting sights are always to be found.

The White Mountains of Northern New England are marvelously attractive, and the "Notch," the "Flume," the "Glen" or the Summit" are but a few of the many features of this wonderful region which you should visit. To one sojourning hereabouts many drives or walks over mountain and dale may be taken, reaping a harvest of pleasure unequaled in these parts; likewise the opportunities for enjoyment that are afforded at the beach resorts are manifold, and the bathing, boating and fishing facilities attract many vacationists.

In no other region can you find so comfortable quarters as those of the hostelries of Northern New England, which are home-like and commodious. The cuisine is invariably of the best, and the service fully equal to that of the metropolitan hotels.

During the summer season the Boston & Maine Railroad sells round-trip tickets to all mountain, seashore and lake resorts of Northern New England and the Maritime Provinces, at reduced rates, and the excursion book which is issued by the General Passenger Department of the Boston & Maine, and which is sent free of expense to applicants, includes a complete hotel and boarding-house list, together with routes and rates to all principal points.

Our Directory

OF OFFICIAL CHANGES IN AUGUST.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Baltimore & Ohio.—D. C. Courtney is Division Master Mechanic at Grafton, W. Va., vice Mr. S. A. Souther.

Chicago, Kalamazoo & Saginaw.—Mr. Ed. Woodbury, of Kalamazoo, has been elected President.

Chicago, Hammond & Western.—General Manager J. P. Lyman has also been elected President.

Chicago Rock Island & Pacific.—A. L. Studer, Master Mechanic at Stuart, Ia, has been transferred to Trenton, Mo., on the Southwestern Division, and Mr. J. B. Kilpatrick, at Valley Junction, Iowa, has his jurisdiction extended over the West Iowa Division.

Columbus, Hocking Valley & Toledo.—N. Monsarrat has been elected Vice-President.

Columbus, Sandusky & Hocking.—W. E. Guerin is elected President and Charles Parrott Vice-President.

Denver, Lakewood & Golden.—Wm. W. Borst has been appointed receiver.

Duluth & North Dakota.—H. Fegraus, of Duluth, has been appointed Chief Engineer.

Galveston, Houston & Henderson.—Mr. F. P. Olcott has been elected President and Mr. J. H. Hill General Manager.

Galveston, Lea Porte & Houston.—S. R. Tuggle has been appointed Superintendent of Motive Power.

Great Northern.—General Manager Chas. Warren has retired. Mr. J. M. Barr, General Superintendent, has been assigned some of the duties heretofore performed by the Manager and the office will be abolished.

Green Bay & Western.—Mr. J. A. Jordan has been elected Vice-President.

Gulf, Colorado & Santa Fe.—Mr. L. J. Polk has been appointed Acting General Manager, vice Mr. B. F. Yoakum, resigned.

Kansas City, Fort Scott & Memphis.—Vice-President Ed. S. Washburn has been elected President of this road and also of the Kansas City, Memphis & Birmingham.

Kansas City, Fort Scott & Memphis.—Mr. D. W. McLean, Master Car Builder at Fort Scott, died last month.

Marietta & North Georgia.—Joseph McWilliams is General Manager, with office at Marietta, Ga.

Michigan Central.—Mr. S. B. Wight is Assistant Purchasing Agent with office at Detroit.

Oregon Central.—J. T. Walch has been appointed Master Mechanic and Master Car Builder.

Oregon Railway & Navigation Company.—Mr. Edwin McNeil has been elected President of the reorganized company.

Plant System.—Mr. Wm. Rutherford, Superintendent of Motive Power, has resigned.

Pittsburg, Chartiers & Youghiogheny.—J. M. Schoonmaker has been elected President, vice J. H. Reed, resigned.

Rio Grande & Eagle Pass.—Miss Mary Powers is Purchasing Agent with office at Laredo, Tex.

St. Louis, Chicago & St. Paul.—C. Millard has been appointed Chief Engineer with office at Springfield, Ill.

St. Louis Southwestern.—J. M. Scrogin is Master Mechanic at Tyler, Tex.; vice Mr. Thomas Irglis, deceased.

St. Louis & San Francisco.—Purchasing Agent E. T. Smith has resigned, and the office is abolished. General Manager Yoakum will purchase all supplies.

Sonora Railway, and New Mexico & Arizona.—E. P. Ripley has been elected President.

Southern.—W. A. Walden has been appointed Master Mechanic at Burlington, N. C., to succeed T. S. Inge, transferred to Columbia, S. C.

Texas, Sabine Valley & Northwestern.—R. B. Levy, Sr., has been appointed Receiver, vice L. H. Hart, resigned.

Texas Trunk.—Mr. William White, Superintendent, has been appointed Receiver to succeed Mr. G. T. Atkins, resigned. Office, Dallas, Tex.

Washington & Columbia River.—J. Evans has been appointed Master Mechanic, vice Wm. Saxton, resigned.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

OCTOBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

IV.

(*Continued from page* 206.)

A systematic description of the shops at Altoona, and of what they contain, would not be easy to write. In fact it would be difficult to devise a comprehensive system, or skeleton, for a complete description. As no attempt at completeness is aimed at in these articles, it will not be necessary to follow any particular method in writing or arranging them—all that will be attempted will be to note and describe the various interesting features which the writer had the opportunity of observing, aiming only to make the descriptions easily comprehensible by the reader.

CHILLED CAST-IRON TOOLS.

The use of chilled cast-iron tools in these shops for lathes, planers and boring machines will probably be a novelty to many of our readers, as it was to the writer. These are used for turning, boring and planing both wrought and cast iron and brass. It is found that they will not stand the service of cutting steel, as the cast iron has not sufficient strength to resist the strain, and the cutting edges of the tools crumble in doing that kind of work.

These tools are cast from the ordinary iron used for making chilled wheels, the point or cutting end being chilled, and then ground in the usual way. It is said that they stand equally as well or better than steel tools do, and are very much cheaper, and are cast in exactly the right form required, and being made from a pattern, are uniform in shape and size.

The various kinds which are made and used are shown in the engraving herewith, Fig. 1, which was reproduced from a photograph, and the list of sizes will indicate the uses in which they are employed.

PNEUMATIC ASH-HOIST.

The economical handling of ashes from locomotives is a problem on which a great deal of thought and and ingenuity has been exercised. At Altoona several pneumatic ash-hoists have been designed and erected, and are now working very satisfactorily. The latest of these is illustrated in Fig. 2 and, as will be seen, consists of an iron frame resembling a gallows, with capacity for hanging half-a-dozen culprits at once. The frame extends across three tracks. The view shown in Fig. 2 was taken from a point near the westerly door of round-house No. 3, the latter being behind the observer.* A part of the sand-house, which is indicated in the plan, is shown on the right side of the engraving. The track on which the engine is standing leads directly into the round-house. It will be seen that this track has a pit underneath and in front of the engine. The bottom of this pit has a narrow-gage track on which small trucks run and carry what may be called bifurcated buckets to receive the ashes as it is removed from the ash-pans of the engines.

The tops of two of these buckets are shown in the pit, and one is suspended over the car, alongside of the engine, with its two halves opened, to deliver its contents into the car below. When an engine is to be de-ashed—to coin a word—one of the trucks with a bucket on it is run under the engine, and the ashes are raked out of the ash-pan into the bucket. After it is filled either the engine can be run forward or back, so that the bucket can be reached by the hoist, or if the engine is not below the hoist when

* The round-house is shown in the plan published last month, page 204.

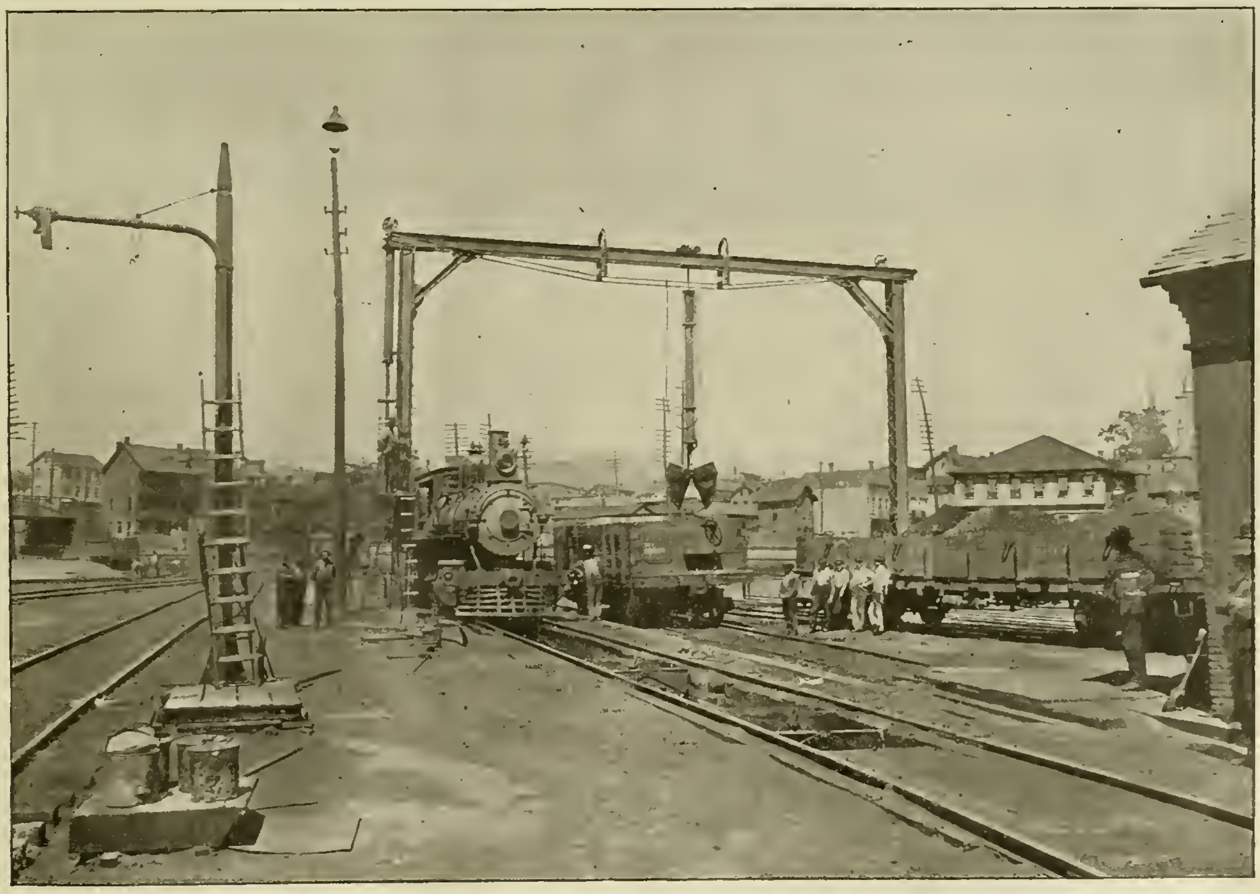
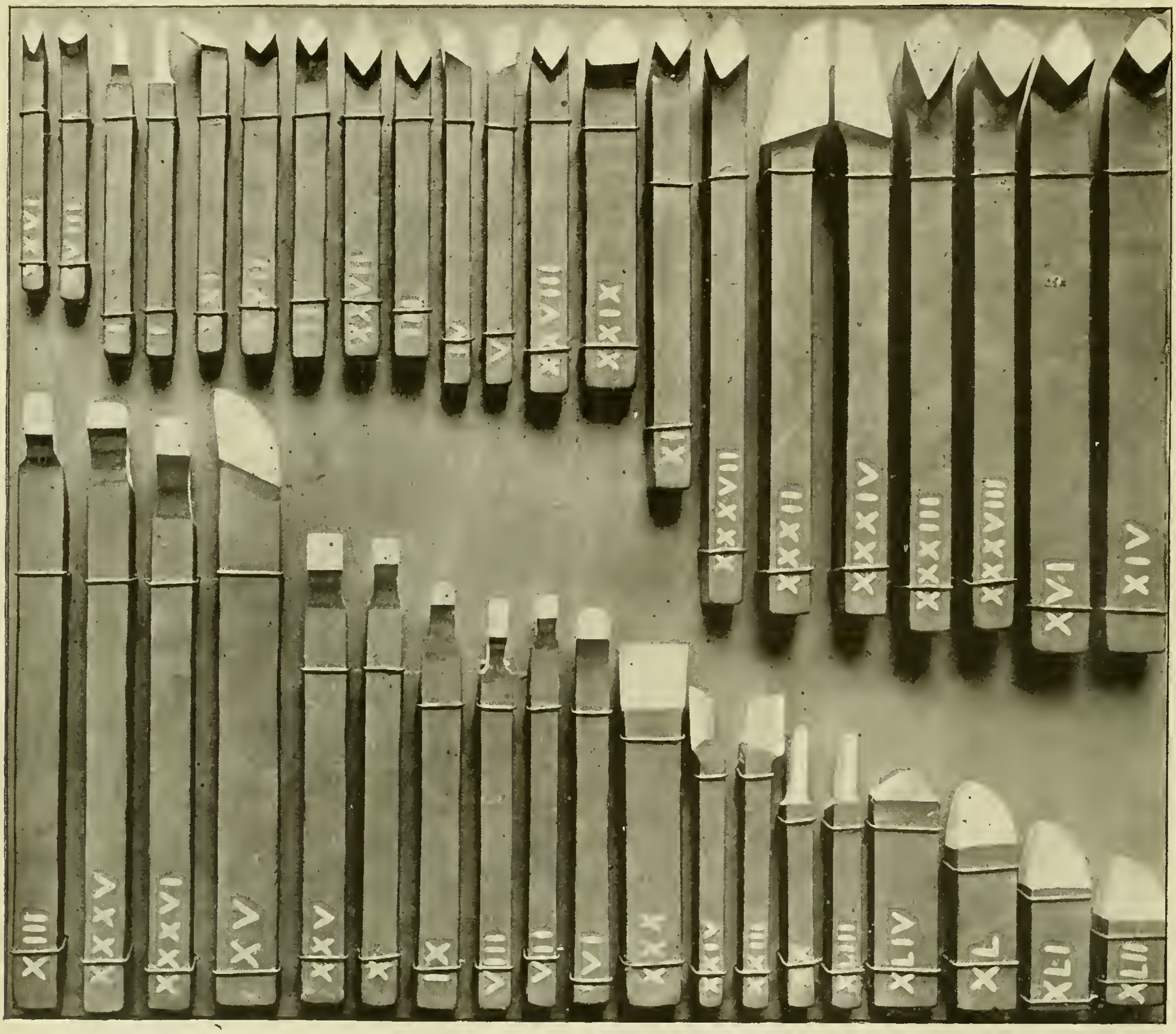


Fig. 2.—Pneumatic Ash Hoists in the Altoona Yard of the Pennsylvania Railroad.



LIST OF CAST-IRON TOOLS.

I.	Round nose for iron and brass	1⅜ in. × ⅝ in. × 8⅜ in.
I.	Thread tool for wrought and cast iron	1⅜ in. × ⅝ in. × 8⅜ in.
II.	Diamond point "right hand" "lathe"	1⅜ in. × ¾ in. × 8½ in.
III.	" " " "	1½ in. × ⅞ in. × 8½ in.
IV.	Diamond point side tool, "right hand" "lathe"	1⅜ in. × ⅝ in. × 9 in.
V.	Diamond point side tool "right hand" "lathe"	1⅛ in. × ⅝ in. × 9 in.
VI.	Round nose for lathe or planer	1½ in. × 13/16 in. × 9¾ in.
VII.	Square " " planer	1¼ in. × 11/16 in. × 10¼ in.
VIII.	" " " lathe	1⅜ in. × ¾ in. × 10 in.
IX.	Round " " " or plainer	1 in. × 1 7/16 in. × 10⅝ in.
X.	Square " " "	⅞ in. × 1½ in. × 11½ in.
XI.	Diamond point for lathe or planer	1½ in. × 1 in. × 11¾ in.
XIII.	Square nose for lathe or planer	2 in. × 1¼ in. × 15 in.
XIV.	Diamond point for lathe or planer	1½ in. × 1½ in. × 15⅝ in.
XV.	Oyster knife for planer	1½ in. × 1½ in. × 15¼ in.
XVI.	Diamond point for planer or lathe	1½ in. × 1½ in. × 15½ in.
XVII.	Diamond point for planer, "left hand"	1½ in. × ⅞ in. × 8½ in.
XVIII.	Diamond point for lathe	1⅝ in. × ⅝ in. × 7 in.
XX.	Round nose for lathe	⅝ in. × 1 in. × 7 in.
XXI.	Boring tool " "	1 5/16 in. × ⅝ in. × 8⅜ in.
XXIII.	Left hand side or facing tool for lathe	1⅛ in. × ⅝ in. × 8 in.
XXIV.	Right hand side or facing tool for lathe	1⅛ in. × ⅝ in. × 8 in.
XXV.	Square nose for planer	1 1/16 in. × 1½ in. × 11½ in.
XXVI.	Diamond point for lathe	1⅛ in. × ⅛ in. × 6¾ in.
XXVII.	Diamond point for lathe or planer	⅞ in. × 1½ in. × 8½ in.
XXVIII.	Diamond point for planing and facing cylinders	15/16 in. × 1⅜ in. × 9⅜ in.
XXIX.	Diamond point for planer or facing mill	1¼ in. × 1¼ in. × 9⅛ in.
XXX.	Square nose for turning cylinder flanges	1⅜ in. × 1⅜ in. × 9 in.
XXXII.	Side tool for axle lathe or planer	2 in. × 1 in. × 14½ in.
XXXIII.	Diamond point for axle lathe or planer	2 in. × 1 in. × 15 in.
XXXIV.	Side tool for axle lathe or planer	2 in. × 1 in. × 14⅝ in.
XXXV.	Square noso for axle lathe or planer	2 in. × 1 in. × 15 in.
XXXVI.	" " " " " "	2 in. × 1 in. × 14½ in.
XXXVII.	Diamond point for planer	1½ in. × ⅞ in. × 14½ in.
XXXVIII.	" " " axle lathe	2 in. × 1 in. × 15 in.
XL.	Tools for boring cylinders. (Baldwin)	1½ in. × 1½ in. × 5¾ in.
XLI.	" " " " "	1½ in. × 1½ in. × 4¾ in.
XLII.	" " " " "	1½ in. × 1½ in. × 3⅝ in.
XLIII.	Square nose for lathe	1¼ in. × ¾ in. × 6¾ in.
XLIV.	Boring tools for driving boxes	1⅝ in. × 11/16 in. × 6 in.

Fig. 1—Chilled Cast-Iron Lathe and Planer Tools Used in the Altoona Shops of the Pennsylvania Railroad.

the ashes are raked into the bucket the truck in the pit can be moved so as to bring the bucket within reach of the hoist. The latter consists of a pneumatic cylinder and piston, to which the open bucket in the engraving is suspended. This is carried by a little trolley—shown in the engraving—which runs on the top of the transverse beams. On the left side of the gallows frame, as will be seen, is another vertical pneumatic cylinder, the piston of which is connected to a wire rope that is carried over pulleys at each end of the horizontal beam, and is attached to the trolley, which can thus be moved transversely to the track. The buckets filled with ashes can thus be hoisted from the pit by the vertical cylinder shown above it, and can be moved laterally by the other cylinder, over the car and opened so as to deliver its contents into the car below. This is all done in less time than it will

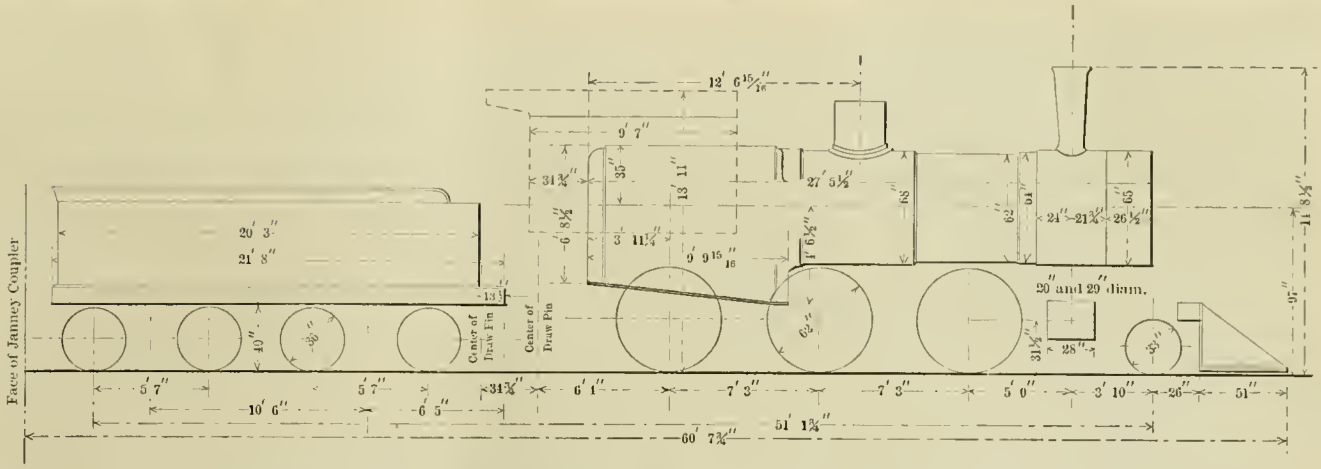


Fig. 3.—Outline of Compound Mogul Locomotives—Pennsylvania Railroad.

take to read this description of it, and saves much work of a very disagreeable kind.

PNEUMATIC SANDING APPARATUS.

The ㄱ-shaped pipe or stand, with a ladder leaning against it, shown on the left side of the engraving, is one of the pneumatic sanding appliances which are used to fill the sand-boxes of locomotives. The sand-house on the right has a sand-dryer of a usual kind. A cylindrical reservoir or tank, 3½ feet in diameter and 5½ feet deep, is placed below the dryer, usually under the floor. This receptacle has a valve on top, through which the sand is fed into the tank. From the bottom of it a pipe communicates with the vertical ㄱ pipe shown in the engraving. The valve on top of the sand reservoir opens inward, so that when compressed air is admitted the valve is closed, but it passes through the sand and into the pipe at the bottom and thence to the ㄱ pipe, and in doing so carries the sand with it. The end of the pipe has a valve and hose which are shown, the hose being intended to conduct the sand to the sand-boxes. A few minutes is all the time required to fill a sand-box, which is done by simply turning on the compressed air when the reservoir contains a sufficient quantity of sand.

COMPOUND LOCOMOTIVES.

A very interesting series of experiments has been in progress on the Pennsylvania Railroad for some time past. It was determined by the managers of the company a year or more ago to make a thorough test of the compound system for locomotives, and to do this four mogul freight engines were built all alike, excepting that a different system of compounding was adopted in each engine. The diagramatic engraving, Fig. 3, herewith, gives the proportions and principle dimensions of these engines. The systems of compounding which were adopted were the Gölsdorf, Van Borries, Pittsburgh and Richmond.

These engines were all completed some months ago, and have since been undergoing a most thorough series of tests in actual service, the results of which cannot help being very interesting to railroad men generally. At the time of our visit to Altoona the tests were not completed, so that no results can at present be given. All that can be said is that a very decided economy in coal consumption by the compound over the simple engines was indicated by the tests so far as they have been made.

We are indebted to Mr. Vogt and Mr. Casanave for a series of diagrams showing the principal features of the various compound systems as they have been applied to the engines referred to.

THE GÖLSDORF SYSTEM.

Fig. 4 represents a transverse section through the cylinders of the engine to which this system of compounding was applied. It will not be necessary to explain to many of our readers that in compound locomotives some special provision must be made to admit steam to the low-pressure cylinder in starting; but in order that those who are not familiar with the compound principle may read this understandingly it may be said that in such engines steam is admitted first to the high-pressure cylinder, and after acting on the piston, it is allowed to escape to a larger or low-pressure cylinder, where it again acts on another piston, and then escapes up the chimney. As the steam is admitted first to the high-pressure cylinder, unless some special provision is made therefor,

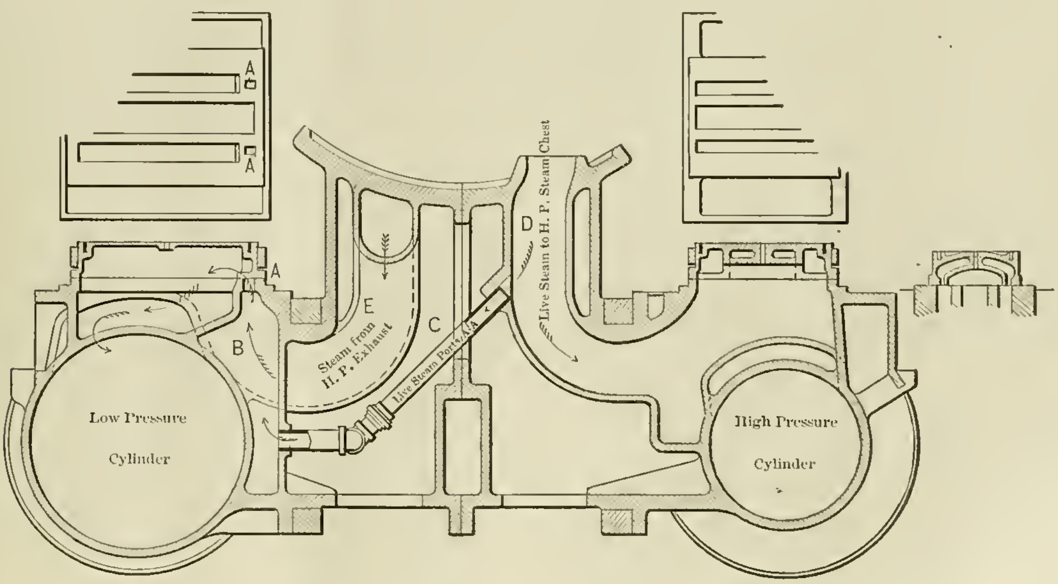


Fig. 4.—Golsdorf System of Compounding as applied to a Mogul Locomotive by the Pennsylvania Railroad.

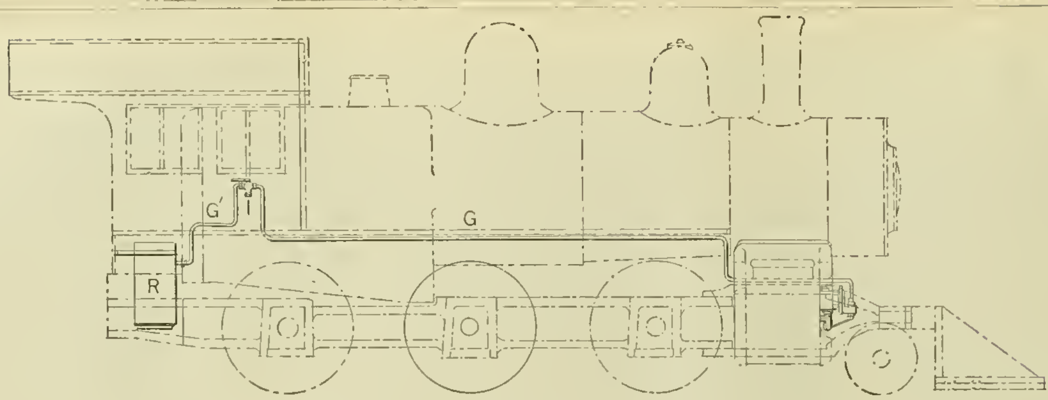
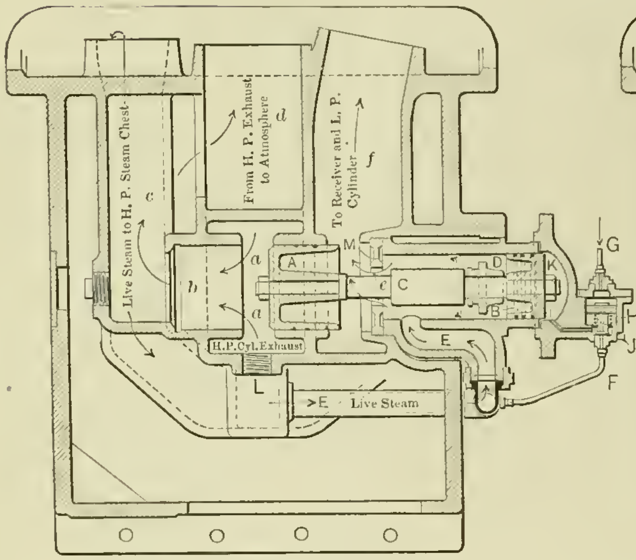
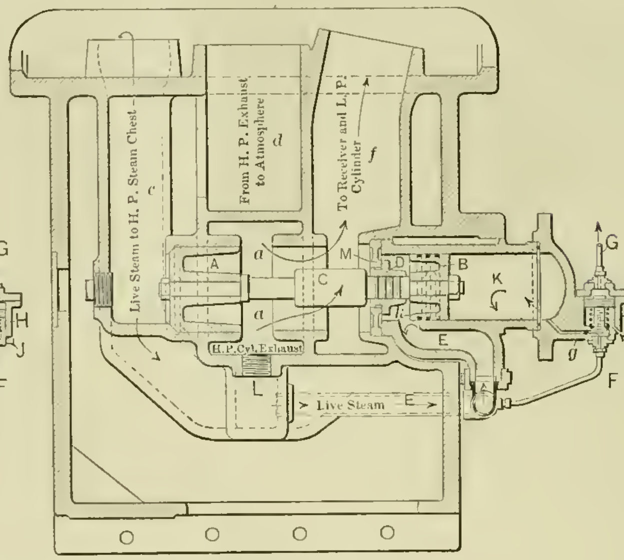


Fig. 5.



POSITION OF VALVE WHEN ENGINE IS WORKING SIMPLE.

Fig. 6.



POSITION OF VALVE WHEN ENGINE IS WORKING COMPOUND.

Fig. 7.

The Von Borries System as Applied to a Compound Mogul Locomotive by the Pennsylvania Railroad.

no steam would enter the low-pressure cylinder during the first revolution of the wheels, and, as a matter of fact, owing to the cylinders often being cold in starting much of the steam which is then admitted to them is condensed and for a number of revolutions little would flow into the second cylinder. Furthermore, the engine might be standing in such a position that the low pressure piston was at or near the end of its stroke and unable to exert much tractive effort. It is therefore essential in compound locomotives to provide means for admitting steam direct from the boiler to the low-pressure cylinder in starting.

In the Gölsdorf system this is accomplished by openings *AA*, which are made in the valve-seat. One of these is shown in the sectional view in Fig. 4, and both of them in the plan view of the valve-seat just above the left-hand cylinder. These openings communicate with a cavity in the cylinder casting, which is connected by a pipe *C* to the steam-pipe *D* of the high-pressure cylinder. In starting when the valves are worked at their full stroke or nearly so their steam edges will uncover the openings *AA*, and by means of the pipe *C* live steam will thus be admitted to the low-pressure steam-chest and cylinder. After the engine is started, and the valves are worked at considerably less than their full stroke, then the parts *AA* are not uncovered and no live steam can enter the low-pressure cylinder, but it is supplied from the exhaust of the high-pressure cylinder which is connected to the pipe *E*.

From the steam-chest of the low-pressure cylinder the live steam passes into the receiver and thence into the high-pressure cylinder, entering on that side of the piston therein which is opposite to that in which the movement of the piston ought to take place.

Thus the steam entering the high-pressure cylinder will exercise a certain counter pressure which, however, will be overcome by live steam from the boiler as soon as the position of the crank undergoes the slightest alteration, such live steam from the boiler entering directly into the high-pressure cylinder.

When the low-pressure slide-valve assumes such a position that the port which until then has been open is closed, the direct admission of steam into the low-pressure cylinder will be discontinued, and, therefore, any injurious counter-pressure that might otherwise result therefrom, is completely obviated, so that the locomotive can then be started by the steam pressure exerted upon the high-pressure piston alone.

THE VON BORRIES SYSTEM.

Professor Woods, in the last edition of his book on "Compound Locomotives," says that "after a number of years' experience with automatic starting gears, that give increased power to compound locomotives, during a part of the first revolution, Mr. von Borries has reached the important conclusion that an independent exhaust with a high-pressure cylinder, such as used by Mallet, is necessary for two-cylinder receiver compounds, with cranks at right angles, when the locomotive has to start heavy trains or work on comparatively heavy grades."

This device has been adopted in one of the Pennsylvania Railroad compounds. In order to enable the engineer to control the exhaust and the working of the two cylinders, that is, to change them so as to work either simple or compound, a three-way cock I.—shown in the diagramatic view, Fig. 5—is provided, which is connected by a pipe G^1 with the air brake reservoir *R* and by another pipe *G*, with an apparatus on the front end of the cylinder castings shown in Figs. 6 and 7 in sectional views and on a larger scale. In Fig. 6, the parts are represented in the position they occupy when working simple and in Fig. 7 as they are when working compound; *a a* is a cavity which is connected directly to the exhaust of the high-pressure cylinder. From Fig. 7 it will be seen that when the parts are in the position therein shown that the exhaust steam from the high-pressure cylinder will pass from the passage *a a*, which is connected with the exhaust of the high-pressure cylinder to *f*, and thence to the receiver and low pressure cylinder. The engine then works compound. The parts are held in the position shown by the pressure of steam in the cylinder *K*.

To change the engine to simple working in starting, compressed air is admitted by the three-way cock *I* and pipe *G*, Figs. 5 and 6, to the operating valve *H*. This has a small piston inside, which is connected to a double-seated valve below it. When air is admitted above the piston it is forced down, which closes the opening below the valve and shuts off communication with the pipe *F*. At the same time the valve leaves its top seat, which opens communication through the passage *g*, between the cylinder *K* and the outlet *J*, which is open to the atmosphere. The steam in *K* can thus escape. The opposite end *k* of the cylinder is connected by pipes *E E* with the live-steam pipe. Consequently that end of the cylinder is filled with steam which acts in the piston *B*, which moves it and the parts with which it is connected toward the right or into the position shown in Fig. 7. From this it will be seen that by this movement the piston *A* has been unseated and that communication has been opened from the cavity *a a*, which communicates with the exhaust of the high-pressure cylinder to *d*, which latter eads to the atmosphere.

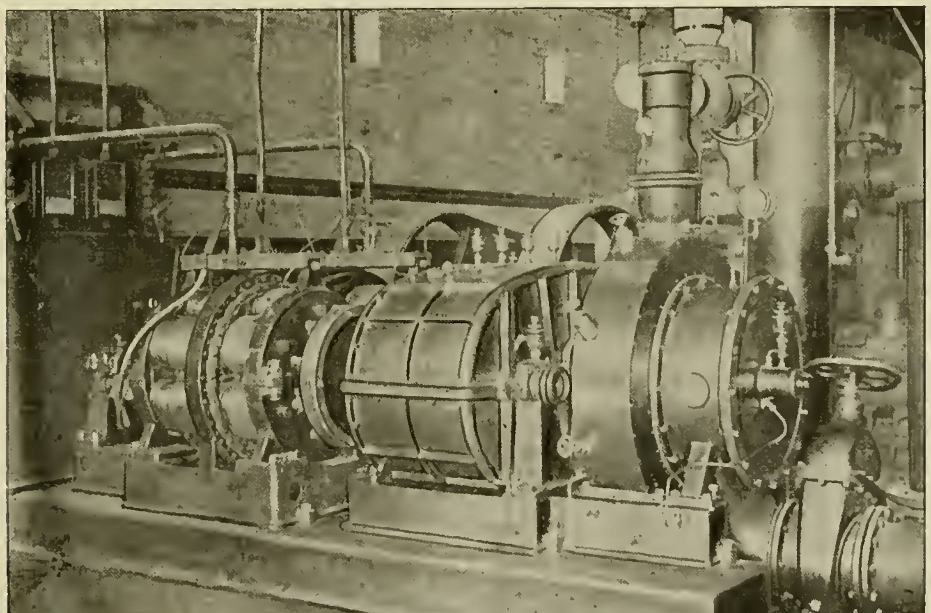
When the parts are in the position shown the exhaust steam from the high-pressure cylinder can therefore escape directly through the passage *b* to *d*, as indicated by the arrows, and thence to the open air. This cylinder is then working simple. At the same time live steam can flow through the pipes *E*, *E*, passage *e*, into *f*, which is connected with the reservoir and low-pressure cylinder. Under these conditions both cylinders will work simple. It should be explained that the parts shown in the engraving, that is the pistons *A* and *B*, and plug C^1, are kept in the position in which they are represented by the pressure of the live steam on the left side of the piston *B*.

To work the engine compound the air pressure in the operating valve *H* is released by the three-way cock. The steam pressure in the pipe *F*, below the valve, will then raise it and close communication from the cylinder *K* and the atmosphere by the passage *J*, and open a passage from *F* through *g* to *K*, thus admitting live steam to the right side of the piston *B*, which, by reason of the greater effective area on that side, due to the reduction of pressure resulting from the steam flowing to the low-pressure cylinder, will be moved towards the left. This movement first shuts off live steam communication at *e*, Fig. 6, from the pipe *E E* to the receiver, and low-pressure cylinder, by means of the reducing plug *C* and then closes communication between the high-pressure exhaust and atmosphere by the seating of the valve *A* and at the same time opening communication between the high-pressure exhaust passage *a a* and the low-pressure cylinder through the receiver passage *f*. The engine is thus entirely under the control of the runner and can be instantly changed from simple to compound working or *vice versa*.

The engravings and explanation have occupied so much space that the description and illustrations of the other two compounds must be reserved for the next article.

Performance of a 300-Horse Power De Laval Steam Turbine in an Electric Lighting Station.

Some time ago the Edison Electric Illuminating Company, of New York, contracted with the Société de Laval, of Paris, for two 300 horse-power De Laval steam turbines. One of these now installed in the Twelfth street station in New York has recently been tested by Messrs. Breguet and Van Vleck, the former representing the builders and the latter the purchasers.



300-Horse Power De Laval Turbine at Twelfth Street Edison Station, New York.

The turbine disc has a diameter of 29½ inches and a thickness through the blades of about $\frac{4}{16}$ inch, and it runs at 9,000 revolutions per minute. The motion is transmitted by gearing to two Desroziers dynamos running at 750 revolutions. The entire equipment of one turbine, its gearing and two dynamos occupy a floor space of 13 feet 3 inches by 6 feet 5½ inches, and a height of only 4 feet 3 inches. When operating condensing with a steam pressure of 145 pounds above the atmosphere and a vacuum of 26 inches, the steam consumption was guaranteed to be not more than 18.7 pounds per brake horse-power under full load.

In the accompanying illustration is shown the apparatus tested. The steam is supplied to the turbine through the large valve on top of it and the jets are turned on and off by the small valves around the periphery of the casing, three of them being in sight in the photograph. The exhaust passes out through the large valve below and to the right of the turbine. The gears are in the casing to the left of the turbine and there is a second dynamo directly back of the one in the foreground.

The tests were each of six hours' duration and all readings were taken by two observers. The result of the full load test is as follows:

Average of readings:

+	+	−	−
127.25 volts.	692.48 amps.	128.26 volts.	709.18 amps.

127.25 × 692.48 = 88,118.080 watts + side
128.26 × 709.18 = 90,959.427 " − side

Avg. watts.... 179,077.507 " both sides

179,077.507 is 90 per cent. of 198,975.01 watts = 266.72 h. p. × 6 = 1,600.32 h. p. hours.

Weight of water discharged from air pump, 6 hrs. = 27,763 lbs.
H. P. hours developed..........................6 hrs. = 1,600.32
Lbs. of water per B. H. P. hour.. .. ..17.348 lbs.
Lbs of water per E. H. P. hour........................ ....19.275 lbs.

The result of tests with varying loads is given below, the number of jets in use varying from two to seven in the different tests:

No. of jets used.	Average load + Amps.	Average load − Amps.	Average watts +	Average watts −	Per cent. of full load.	Vacuum.	Pounds of steam per E. H. P.
2	153.78	147.15	18.707	18.283	18.50	27.	27 35
4	433.60	455.80	54.156	57,886	56.02	26.43	20.22
6	700.85	718.65	87.746	91.268	89.51	26 07	19.75
7	771.94	787.33	97.418	100.856	99.14	25.79	19.95

In making these tests the power readings were obtained from the delivery of the dynamos, and the electrical horse-powers given above and the steam consumptions per electric horse-power are therefore the result of direct observation. The brake horse-power is calculated by assuming that the dynamos have an efficiency of 90 per cent.

We understand that these are the first Laval steam turbines of such large power to be put into commercial use in this country.

Communications.

A Novel Method of Obtaining Dynamometer Cards.

PHILADELPHIA, Aug. 25, 1896.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

At a recent engine test near Stroudsburg, Pa., conducted by Edwin E. Boyer, M. E., of Philadelphia, a novel instrument to obtain a card from the dynamometer was presented, and caused some little comment.

The dynamometer was the ordinary prony brake, but in place of the customary platform scales, at the end of the arm was placed a spring made from ½-inch steel, wound on a 2-inch core, and designed from Begtrup's formula, to be of such a length as to give a deflection of 3 inches under its maximum load of 2,500 pounds.

This spring was placed in a hollow cylinder which carried a scale graduated for every hundred pounds. On the index of the spring was fastened a pencil which pressed against the card carried by an aluminum cylinder about 3.8 inches in diameter and 3¼ inches high.

This cylinder was operated by clockwork to revolve once an hour, and was so adjusted that the maximum movement of the index (3 inches) was produced on the card.

The ordinate on the card was divided in 25 spaces, each space therefore representing 100 pounds pull, and the abscissa was divided into 120 spaces, each space representing an interval of 30 seconds.

The duration of the test was 8 hours, and indicator cards were taken from each end of the cylinder every 10 minutes.

The necessity of a dynamometer card was caused by the great vibration of the arm of the brake, these vibrations being too great to obtain accurate results with platform scales.

The test was in every respect a success, and reflects much credit on the young engineer in charge. R. M. WILSON.

Tests of Car Wheels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

We have noted with interest the correspondence in your September issue concerning the special tests made on cast-iron wheels by casting a ring of molten iron around the rim of the wheels.

The company with which the writer is connected has made a great many experiments in this direction which are interesting in a sense, but they are entirely useless so far as showing any actual conditions which arise in service.

It would be as possible to prove that a gun was not of proper strength or construction by putting in a charge several times greater than ever would be used in actual service and exploding it. Car wheels are never instantly heated by brake service, but they become gradually, and often rapidly, hot from the friction of the brakes and on long grades the heat becomes severe, but even then nothing to approximate the heat of a body of *molten* metal as is mentioned in your paper. As a matter of fact the conditions are almost exactly reversed from those of actual service, for in service the brake is applied cold and friction gradually heats the wheel, while in this "test" a great extreme of heat in the shape of molten metal is applied instantly and allowed to gradually cool.

The modern foundry makes car wheels to meet the requirements of the service to which they will be subjected, the same as bridge builders have their beams and trusses of the requisite strength and electricians make their motors of the necessary power, etc.

We might as well claim that by overloading and breaking an engine that all engines of that grade and strength are faulty and dangerous as to assume that wheels subjected to a series of satisfactory tests approximating the actual requirements of service are not safe because one wheel cannot resist the strain of molten metal applied to its rim in a mass 4 inches deep and 1½ inches wide—an amount of heat and strain that would not be applied to the wheel in actual service were it to run a hundred years. C. V. S.

A New Railroad Club.

A railroad club is being organized in Denver whose membership will be made up chiefly of persons connected with the mechanical departments of the railroads in that vicinity. As managers and superintendents already have an organization there, the new club will do well if it will put itself in close touch with those officials, as co-operation between the officers of various departments can be thereby promoted.

Subjects to be Reported Upon at the 1897 Conventions.

Besides the standing committees on Arbitration, Supervision of Standards, Triple Valve Tests, Standard Wheel and Track Gages, and Brake Shoe Tests, the Master Car Builders' Association has appointed committees to report on: 1. Automatic Couplers. (To advise what changes may be desirable in the standard size of Master Car Builders' automatic coupler shank, and to recommend a standard yoke or pocket strap for rear attachment to car.) 2. Uncoupling Arrangements for Master Car Builders' Automatic Couplers. (To consider whether a standard uncoupling device is practicable, and the details thereof, and to recommend a device which would be applicable to the greatest number of couplers possible.) 3. Loading Logs, Poles, Bark and Long Structural Material on Cars. 4. Trains Parting. (To consider the extent and causes of break-in-twos with automatic couplers, and to suggest remedies.) 5. Passenger Car Pedestal and Journal Box for Journal, 4¼ inches by 8 inches. (To suggest designs.) 6. Specifications and Guarantee for Cast-iron Wheels. (To propose a revision of the recommended practice and to consider therewith the form of wheel.) 7. Air-Brake and Signal Instructions. (To confer with a committee from the Master Mechanics' Association and propose a revision of the code adopted in 1892.) 8. Freight Car Buffers. (To report upon experiments about to be made with improved buffers). 9. Box-Car Side and End Doors. (To submit designs for adoption.) 10. Arch Bars and Column Bolts for Diamond Trucks. (To recommend forms in detail, for cars of 60,000-pounds capacity, and to submit designs for same for cars of 80,000-pounds capacity). 11. Five individual reports on Designs for Steel Car Frames.

The subjects for the Master Mechanics' convention are as follows: 1. Exhaust Nozzles and Steam Passages. (Discussion of the report for 1896 is made the first order of business for 1897. Members are requested to co-operate with the committee by experimenting upon its conclusions and reporting to it.) 2. Counterbalancing Locomotives. (To designate a number of roads to confirm or disprove the recommendations in the report of 1896.) 3. Truck Swing Hangers. (The proper angle for swing beam hangers in locomotive trucks.) 4. Locomotive Grates. (For burning anthracite coal.) 5. The Apprentice Boy. (To recommend a course of shop training for apprentices, and to make recommendations in regard to their technical education.) 6. Best Metal for Cylinders, Valves and Valve Seats. 7. Boiler Jackets. (Which is the most economical, a boiler-jacket of planished iron or of common sheet-iron or sheet steel, painted?) 8. Ratios of Grate Area, Heating Area and Cylinder Volume. 9. Piecework in Locomotive Repair Shops. 10. Motors: Steam, Air and Electricity. (In a locomotive repair shop what class of work can best be performed by air motors, and what is the relative convenience and economy of air motors, electric motors and steam motors for such work?). 11. Revision of Air-Brake and Signal Instructions.

A Few Facts and Opinions on the Design of Express Locomotives.

The official report of the discussion on express locomotives at the 1895 London meeting of the International Congress has recently been published, and from it we have gleaned the following remarks by various speakers, some of which are interesting because of the information conveyed, while others serve to show the lack of information on the details of American practice existing in Europe.

Mr. Aspinall, in speaking of crank axles, said: "I am very often asked by American engineers, how long these crank axles last? I have not given any figure in the paper, and I would mention that a great many erroneous views seem to exist on this point. It so happens that in this country we have to make returns to our Board of Trade of all axles which break in service, and not the axles which are taken out in the workshops by reason of a flaw. The result is, that a certain number of figures exist at the Board of Trade which show that a certain number of axles have broken after, perhaps, having run a comparatively short time, and those figures are published. As a consequence, people often infer that the life of a crank axle is very short. This is quite a mistake. It is shorter than people would like, no doubt, but we have many axles running 400,000 miles. I have had a number which have run up to 600,000 miles, which were taken out when the engines were rebuilt, and, had it not been that they were of an old pattern, would have been good for further service. It is, I think, desirable to lay stress upon this point, because our Board of Trade, and others who write in some of the technical journals, have an idea that when axles have run, say 200,000 miles, they ought to be taken out and condemned."

In discussing counterbalancing, Mr. Webb, of the London & Northwestern, was asked for his rule for determining the weight of the balances, and replied as follows: "In the case of non-compound engines we put weights in the driving wheels equal to half the weight of the reciprocating parts, plus the whole of the weight of the revolving parts. In our compound engines, for the high-pressure wheels, we use the same rule as above, but in the low-pressure wheels we put weights equal to the whole of the revolving and reciprocating parts combined, and we find that this practice gives very satisfactory results in the steadiness of the engine. The weights so obtained are not excessive."

On the subject of the use of leading trucks, Mr. Worsdell, of the Northeastern Railway, gave the practice of his road as follows: "We use the bogie principle entirely for our express engines now, because I found out in actual practice that it gives the drivers very much greater confidence in running if they have a four-wheeled truck in front. Unfortunately, the North Eastern Railway has a number of curves, and most of our main-line stations are on curves, and it is a very difficult matter to start away from these stations, especially at Newcastle, where we have a reverse curve to contend with, and I am very strongly in favor of the bogie principle for express engines. The express engines on the North Eastern Railway run at very high rates of speed with some of the trains, and whereas I found that with the same class of train with an express train having a single pair of wheels in front our men were in the habit of losing time, I also found out from the men themselves that they did not like to run at a high rate of speed owing to having a single pair of wheels only in front."

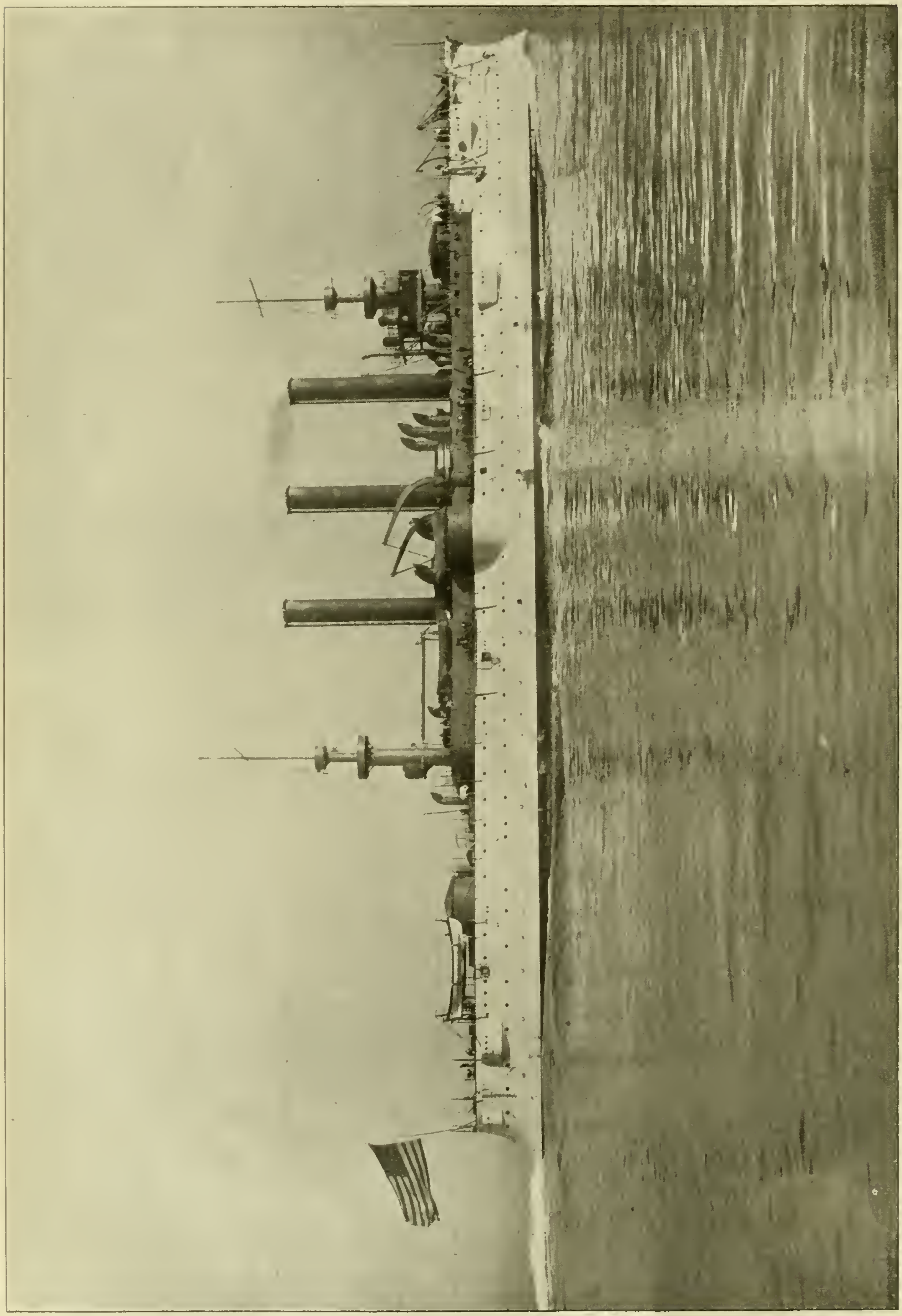
On the same subject, Mr. Baudry, of the Paris-Lyons-Mediterranean Railway, said: "Formerly our express locomotives used to have no leading bogie, but we cannot well compare them with our present engines because the patterns are by no means similar. In our new engines the weight is more concentrated toward the middle, and on the other hand their wheel base is longer. They are also much easier on the road, but this improvement cannot be attributed to the use of a bogie. In order to test the effect of a bogie, the two first locomotives of this pattern were built one with a bogie and the other with a simple carrying axle, but otherwise exactly similar. I must confess that the engine without a bogie was at least as easy upon the road as the one with a bogie, besides being a little lighter and simpler in construction. Nevertheless, I myself declared in favor of the bogie and my company is of the same way of thinking. Indeed, it seems indubitable that the bogie is safer.

In reply to a question about balanced valves, Mr. Worsdell said: "I do not think we have had sufficient experience upon our North Eastern line to give you any valuable information at present upon the subject of the balanced slide valve. We are experimenting with balanced valves, and I am now building 10 engines and putting on the piston valve to engines, but that has been done so very recently and the engines have been working for so few months that we would rather not say anything about them on this occasion. I might just mention with regard to the piston valve that although we have only had some six months' experience in the working of these engines, yet I have put these five engines working in express trains against 10 engines of a similar class and the consumption of fuel in the last six months has effected something like 10 per cent. saving; but whether that will be carried out in the whole 12 months' running is yet to be seen."

At the close of the discussion on slide valves the President made a remark that will read strangely to our readers in view of the widespread use of balanced valves here. He said: "I think we all agree that if a simple and practical method can be found of applying balanced slide valves we shall not refuse to try them on our engines. All that is required is to find a simple and cheap method which will not complicate the machinery, and not be extravagant to maintain."

Mr. Ely, of the Pennsylvania Railroad, being called upon, made this statement of the practice on his road: "It is our practice to build our express locomotives with bogies. Usually these locomotives have two pairs of drivers and a four-wheeled bogie, making eight wheels in all. On the portions of our lines where the passenger trains are not frequent and the trains are very heavy, we use, to some extent, locomotives with three pairs of drivers, making what we term a ten-wheeled locomotive. But we do not approve of this practice for general express service. We believe that the work to be done, taken in connection with the allowable weight upon each pair of drivers, should suggest the design. For light trains locomotives with a single pair of drivers should be prepared if the weight on the drivers is not excessive; we have no such locomotives. For heavier trains two pairs of drivers; for still heavier, three pairs should be used, and so on, always keeping the weight on each pair within the prescribed limits. We think that every pair of drivers adds complications of machinery and friction. For a number of years, especially since pressures up to 200 pounds have been in vogue (on some locomotives we carry 210 pounds pressure), we have felt that the Belpaire principle secures to us perfectly safe and reliable boilers. It is a straightforward construction; all the bolts, etc., are at right angles; and while with it as large a heating surface cannot as well be obtained as by some other forms, we have found them on the whole very satisfactory. As to the question of speed, very little can be said that is new. Unfortunately the builders of locomotives thirty or forty years ago did not have track upon which they could safely speed them—else, I am afraid, our present records would not seem so remarkable. I believe that the locomotive of 30 years ago would probably travel as fast as the locomotive of 1895, so far as the principle of construction is concerned. It is possible for any railroad that has a sufficiently good roadbed to make almost any speed that is desired; but there is an economical limit which should not be exceeded."

The President asked Mr. Ely if he would tell them about certain express trains of which he had been speaking in private shortly before, and Mr. Ely in reply said: "We have a class of trains in America that are called 'newspaper trains.' They are leased or hired by the great metropolitan dailies to carry the early morning papers to seaside resorts, and the train which I spoke to you about made a run of $58\frac{3}{10}$ miles in $45\frac{3}{4}$ minutes. That was without any special preparation. I mean to say the locomotive was one of those used in regular service on these trains. The average speed is between 76 and 77 miles an hour for the whole distance."



The United States Armored Cruiser "Brooklyn" as it Appeared on its Official Trial Trip, August 27, 1886.—Speed, 21 9117 Knots per Hour.

Built by the Wm. Cramp & Sons Engine and Ship Building Co. of Philadelphia, Pa

The United States Armored Cruiser "Brooklyn."

On Aug. 27, the United States armored cruiser *Brooklyn* underwent a very successful trial trip off the Massachusetts coast, developing an average speed of 21.9117 knots per hour over the entire course of 83 miles and reaching a maximum of 22.90 knots, which was maintained for some miles. By this performance the vessel takes a position at the head of her class among the navies of the world, and also earns a premium of $350,000 for her builders, the Wm. Cramps & Sons' Ship and Engine Company, of Philadelphia. It is to be noted that during the trial trip the machinery worked so well that no heating or cutting of bearings took place.

In the full-page engraving accompanying this article we give a view of the vessel taken during the trial trip, and in Fig. 2 we show two half cross-sections through the engine rooms. The length of the cruiser on the load water line is 400.5 feet, the extreme beam 64.68 feet, mean normal draft 24 feet, normal displacement 9,271 tons, displacement on trial 8,150 tons. The indicated horse-power of the engines is placed at 16,000, the normal coal capacity 900 tons and the total coal capacity 1,753 tons. The contract called for a speed of at least 20 knots with a premium of $50,000 for each one-quarter knot in excess of that figure.

The boat is propelled by two screws, each driven by two triple-expansion engines, making four engines in all, each placed in a separate water-tight compartment. The object of this division of the propelling power into four units, is to provide for a reduced engine power for ordinary cruising with more economy than is possible when running large engines at half power. For such cruising the forward engines will be disconnected at shaft couplings provided for the purpose, and the two after-engines will turn the screws. They will then work with practically full power and consequently with economy. Each engine has a high-pressure cylinder 32 inches in diameter, one intermediate 47 inches and one low-pressure cylinder 72 inches in diameter. The stroke of all pistons is 42 inches.

The engines were calculated to make 129 revolutions per minute when generating 16,000 horse-power. The engines are placed in the boat with the high-pressure cylinders forward. The main valves are all of the piston type, there being one for the high-pressure, two for the intermediate, and two for the low-pressure cylinder. The intermediate and low-pressure cylinders are steam-jacketed. The engine frames are of cast steel and of the inverted Y form. The bed plates are also of cast steel and are supported on wrought-steel keelson plates. The crank shafts are each in three sections. All shafting is hollow. The after-section of each propeller shaft is of nickel steel, 17 inches in diameter, with a 11-inch hole through it, except at the propeller fit, where the thickness of metal is nowhere less than 4 inches. The thrust shafts are of mild steel, 16¾ inches diameter, with a 7½-inch hole through them. There is one condenser for each engine, with a cooling surface of about 5,681 square feet. The main circulating pumps are of the centrifugal type, one for each condenser. The air pumps are independent, double-acting, horizontal, two for each engine. In each after engine room there is an auxiliary condenser of sufficient capacity for one-half of the auxiliary machinery.

The steam is supplied by five double-ended main boilers and two single-ended boilers (used either as main or auxiliary boilers) of the horizontal-return fire-tube type. They are 16 feet 3 inches outside diameter and four of the double-ended boilers are 18 feet long, the fifth 19 feet 11½ inches long, while the two single-ended boilers are each 9 feet 4½ inches long. The boiler pressure carried is 160 pounds. The boilers are arranged in three water-tight compartments. The total grate area is 1,016 square feet, and the total heating surface 33,353 square feet.

The forced draft is on the closed stokehold system, and the air is furnished by two Sturtevant blowers for each fireroom. Blake pumps are used for nearly all water-pumping purposes throughout the ship except at the evaporators, where Davidson pumps are installed.

The hull of the vessel is of steel, not sheathed, with a double bottom and close water-tight subdivision, carried up to about 12 feet above the water line. The arrangement of decks above water provides an unusual freeboard and berthing accommodations. It will be noticed from the full-page engraving that there is one more deck forward than aft. There are two military masts with fighting tops. The boats are stowed clear of the blast of the guns, but two life boats are so carried that they may be readily lowered under all conditions of weather.

The hull is protected by means of a steel protective deck worked from stem to stern and supported by heavy beams. The edges of this deck, amidships, are 5 feet 6 inches below the 24-foot water-line, the top of the deck rising to this water line at the center of the vessel. On the slopes over the machinery and boilers the deck is 6 inches thick; on the horizontal portions it is 3 inches thick; forward and abaft the machinery and boilers, to stem and to stern, the deck is at the thinnest part not less than 2½ inches

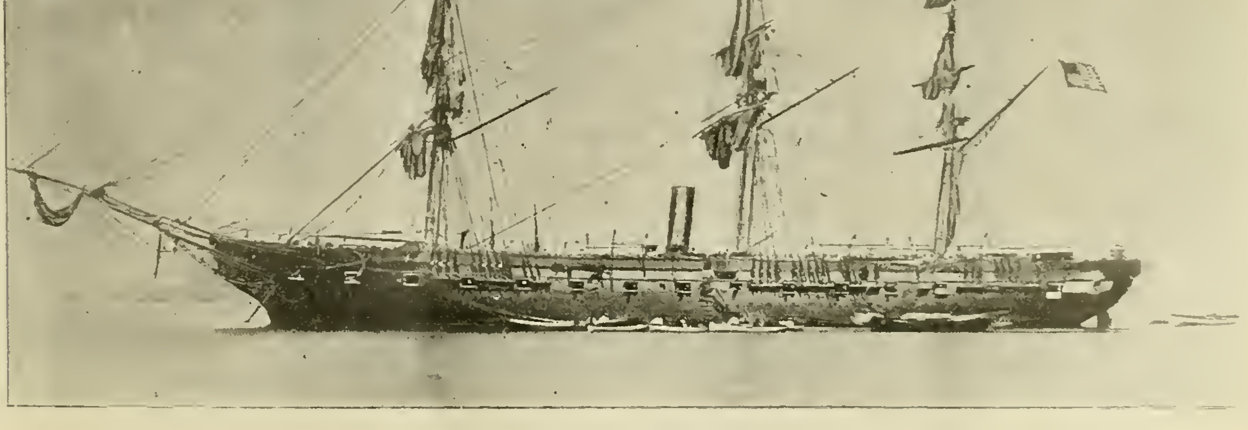


Fig. 3.—U. S. Sloop-of-War Brooklyn—Built 1858.

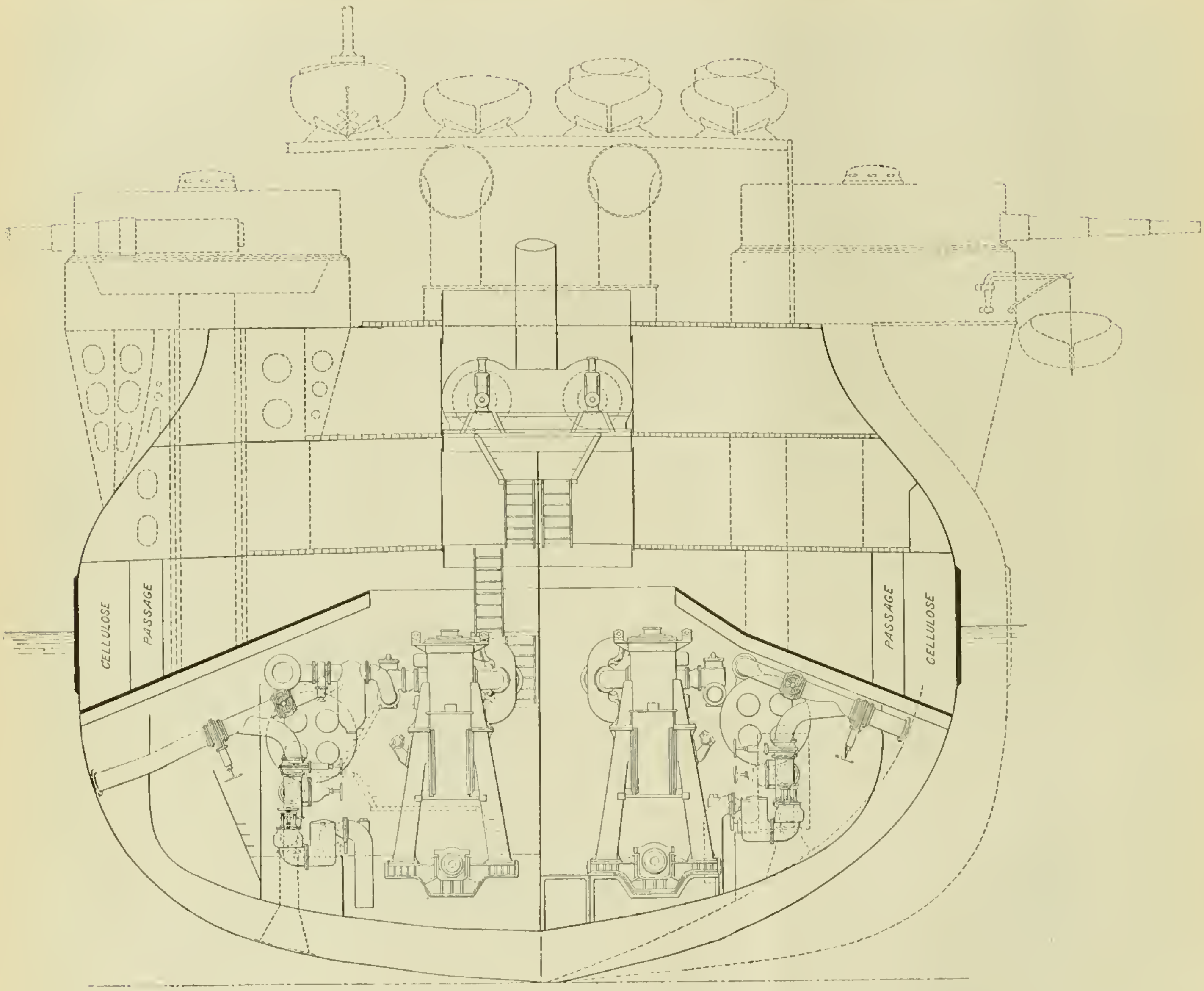


Fig. 2.—Sections of the United States Armored Cruiser Brooklyn.

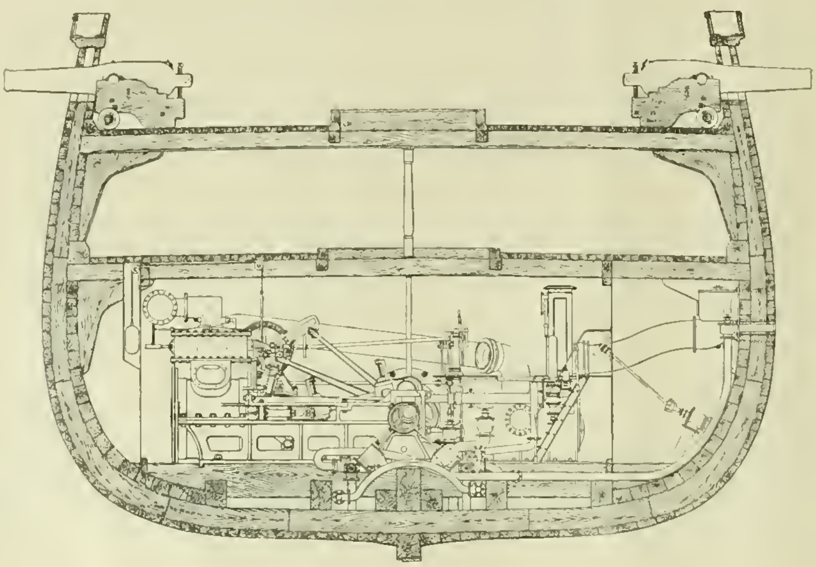


Fig. 4.—Section of the U. S. Sloop-of-War Brooklyn, Built in 1858.

in thickness. Below this deck are placed the propelling machinery, steering gear, magazines, shell rooms, and all that is ordinarily styled "the vitals of a warship."

Protection of the hull from injury to the water-line region is afforded by means of an armor belt 3 inches in thickness, extending the length of the machinery and boiler space, and in depth from 4 feet above the 24-foot water-line to 4 feet 3 inches below it. On the inside of this armor belt and skin plating is a backing of cellulose 3½ feet thick, extending the whole length of the vessel and from the armor deck to the berth deck.

Coal is carried above the armor deck for a length corresponding to the inner bottom, this space between the armor deck and the deck above being subdivided by water-tight bulkheads into 38 coal-bunkers, exclusive of cofferdam and passages. The space forward and abaft these bunkers is subdivided for stores.

A conning-tower 8 inches in thickness stands in a commanding position, having a tube to the protective deck 5 inches in thickness for the protection of speaking-tubes, bell wires, etc.

The battery of the vessel comprises eight 8-inch B. L. R. of 35 calibers, twelve 5-inch B. L. R. rapid-fire guns, twelve 6-pounder rapid-fire guns, four 1-pounder rapid-fire guns, and four machine guns. The 8-inch guns are mounted in four barbette turrets, placed one forward and one aft on the center line of vessel, and one on either side amidships. The guns in the turrets on the center line of the ship have a train of 310 degrees; those in the side turrets fire from right ahead to right astern or train through an arc of 180 degrees each, and it was partly to obtain this desirable feature that the sides of the hull were given the "tumble home" so noticeable in Fig. 2. Thus six 8-inch guns can be trained simultaneously in any desired direction. The centers of the side turrets are distant from the center line of the vessel about 23 feet. The armor forming the barbettes, which will protect the carriages, platforms and turret machinery are 8 inches in thickness for a portion at least equivalent to the train of the guns of the respective turrets, the remaining portions being reduced to 4 inches in thickness. Under the turrets there will be placed 3-inch armor supporting tubes which will also protect the ammunition hoist. The armor of the turrets is 5½ inches in thickness.

The 5-inch guns are protected by fixed segmental shields 5 inches in thickness. The crews of these guns are further protected from explosive shells by splinter bulkheads 1½ inches in thickness, Protection is afforded the smaller guns by shields and extra side plating.

The forward and starboard turrets of the ship are operated by electricity, and the port and aft turrets by steam. As this is the first time that electricity has been used for this purpose in the United States Navy, the operation of the electric machinery for the turrets will be watched with interest.

The torpedo outfit consists of five torpedo tubes, one in the bow and two on each side, six Whitehead torpedoes and a suitable allowance of gun-cotton for mines and miscellaneous purposes.

Distilling apparatus and evaporators supply fresh water, the capacity of the evaporating plant being 10,000 gallons per day. A one-ton Allen ice machine is also installed on the boat.

The electric current for lighting is supplied by three dynamos, and a fourth supplies the current for operating the turrets. The steam steering gear is novel in that it is electrically controlled, that is, the connections to the steam steering engines from the conning-tower are electrical, not mechanical.

The ship will have a radius of action at full speed of 1,758 knots, and a radius of action at 10 knots of 6,088 knots. The complement of officers and men will be 561 persons.

The many steps in the advancement of marine engineering and naval construction have followed each other so closely in the last few decades that few of us stop to think of how much has been accomplished in a short time. To illustrate the rapidity of this progress we have reproduced, in Figs. 3 and 4, a photograph and cross-section of the old United States sloop-of-war *Brooklyn*, these engravings being on the same scale as those of the new *Brooklyn*. In Fig. 2 the engines are shown as they appear looking aft, but we have added in dotted lines the amidship turrets, guns, etc., also the amidship section to make possible a comparison with Fig. 4. A correct idea is therefore obtained as to the relative size of the two boats, and their cross-sections also give a somewhat imperfect idea of the difference in the magnitude of the propelling machinery. In comparing the two cross-sections the reader has to bear in mind that there are twice as many engines on the new *Brooklyn*, as seen in Fig. 2; there are also seven boilers on the new, as against three on the old, to say nothing of electric-lighting plants, refrigerating and evaporating machinery, turret-turning engines, hydraulic machinery, steam steering apparatus, etc., etc., none of which were to be found on board men-of-war built 40 years ago.

The old *Brooklyn* was built in 1858, and cost $417,921. It had auxiliary steam power in the shape of a double horizontal engine driving a single screw. The steam cylinders were 61 inches in diameter and 33 inches stroke. The principal dimensions were as follows: Length between perpendiculars, 233 feet 4 inches; breadth, 43 feet; mean draft, 19 feet 6 inches; displacement, 3,000 tons; indicated horse-power, 1,116; speed, 10 knots; coal capacity, 300 tons. Complement: Officers, 23; men, 268; total, 291.

After a most creditable career the boat was sold in 1891 for $13,128

A brief study of the two sets of engravings accompanying this article will not only impress upon any thoughtful person the great changes introduced in less than 40 years into naval warfare by modern guns and armor and by the use of steam for the propelling power, but ought to convince every reader in an equally impressive manner of the reliance which must be placed upon the engineer officers in designing, building and operating these modern vessels. The engineer, though at present not accorded his proper status in official circles, is the leading spirit in all this work. Without him such marvelous vessels could not be built, and if built could not be operated for a single day.

We are indebted to Commodore Melville, Chief of the Bureau of Steam Engineering, U. S. N.; Commodore Hichborn, Chief of the Bureau of Construction, U. S. N., and Mr. W. H. Ross, of Philadelphia, for the drawings and photographs from which our engravings were made.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.

BY OSCAR ANTZ.

(*Continued from page 217.*)

FREIGHT TRUCKS—(CONTINUED).

To relieve the body of the car from shocks due to running over rough places in the track, springs are introduced between the spring-plank and the truck bolster. Steel springs, both of the coil and the elliptic pattern, are used for this purpose; the use of the latter is, however, almost entirely confined to live stock and other cars on which it is desired to obtain a more than usually easy motion. The bolster springs are placed as nearly as possible on the line of the archbars, so as to relieve the spring-plank of undue strains, and they are kept in place by being set in pockets which in their turn are fastened to either spring-plank or truck-bolster, or merely rest on the former, dowels or lugs being provided to prevent their displacement.

Spiral springs are usually arranged in groups, varying in number from three to six, or even more springs to each group, four being the usual number for modern cars. The springs are of such capacity that they are slightly compressed with the weight of the car body empty, and the total capacity is somewhat in excess over the pressure that can be brought to bear on each spring when the car is fully loaded. Single coil springs are generally used for each member of the group and the diameter of the steel from which they are made varies from ¾ to 1¼ inches, 1 inch being the usual size. Springs made from steel, the section of which is not a circle, are used somewhat, but very little on recently built cars. The diameter of the bolster springs usually runs from 5 to 6 inches and their length from 6 to 7 inches, where four spring are used to each group.

With the modern large cars, the load which can be carried is about twice the weight of the car or over three times the weight of the body alone, and the compression of the springs is therefore considerable when the car is loaded, if the spring is light enough to give an easy motion when the car is empty.

To obtain a spring which has a minimum resistance under a light weight and a much larger one under a heavy load, two coils can be used for each member of the group, the inner coil being made shorter than the outer one, so that it will not be under any strain until the outer coil has been compressed a certain amount,

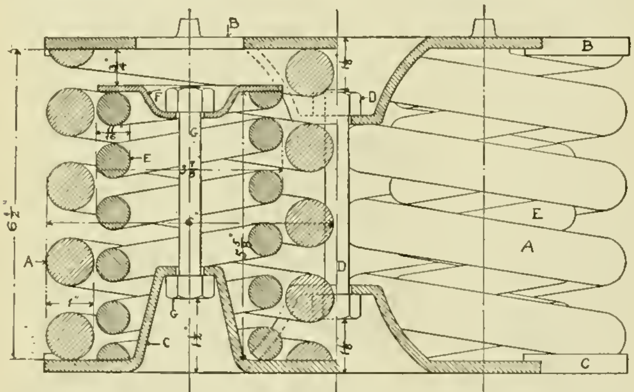


FIG 42

say slightly over the compression due to the weight of the car body alone.

Such a spring is shown in Fig. 42, where *A A* are the outer coils, 6 inches in diameter and 6 inches long, made of 1-inch diameter steel wire; there are 4 springs to a group, which are held in place by the two malleable iron or pressed steel plates, *B* and *C*, which are fastened together by the bolts and nuts, *D D*. The inner coils, *E E*, are $3\frac{7}{8}$ inches in diameter and $5\frac{5}{8}$ inches long, made of $\frac{11}{16}$-inch steel, and held between the lower spring plate, *C*, and cap, *F*, by means of the bolt, *G*. As will be seen, this spring will be compressed against the resistance of the outer coil alone until the cap *F* strikes the upper spring-plate *B*, when the inner coil comes into action, as well as the outer one, increasing the resistance of the spring about double. In designing a spring like this, care must be taken that the bolts *D* and *G* are short enough so that they will not interfere with the spring being being compressed to its full capacity.

TRUCK BOLSTERS.

Until very recently, wood was almost the only material used for truck bolsters of freight cars, but with the extensive introduction of iron in car construction, it has almost superseded wood for this purpose, at least on a number of large roads. Iron was first introduced into truck bolsters in the shape of plates inserted into the bolster, or bolted between the several parts into which it was cut, forming the so-called sandwiched or composite bolster, one great objection to which is that the wood shrinks and leaves the bolts loose, thereby making the bolster weaker perhaps than one of all wood. More recently arches of

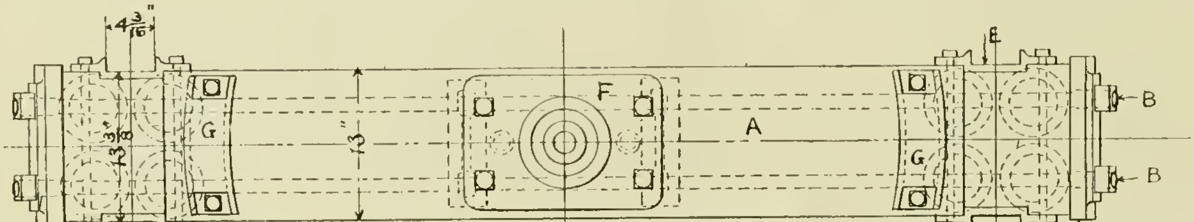


FIG 43

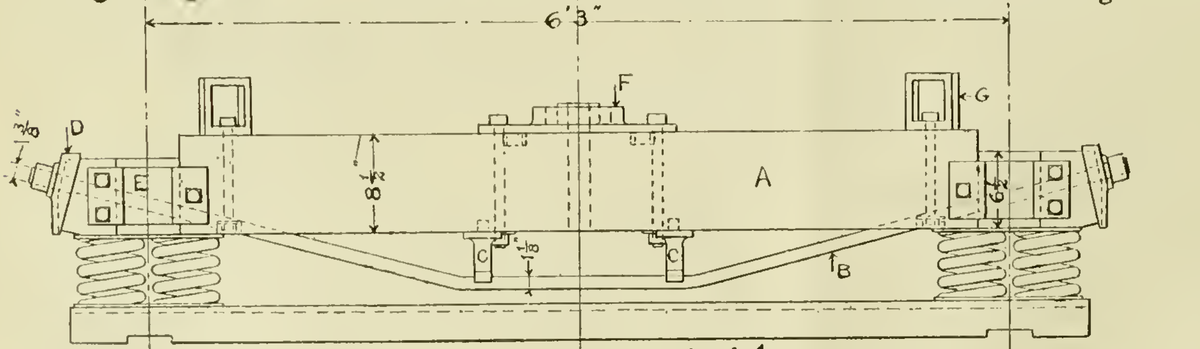


FIG. 44

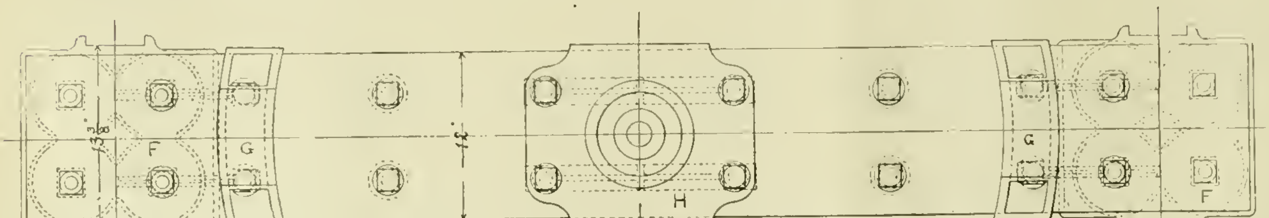


FIG. 46.

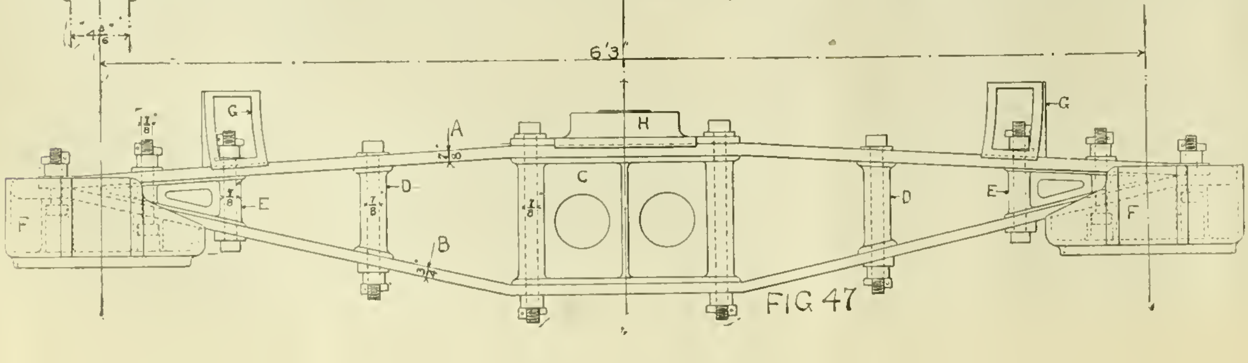
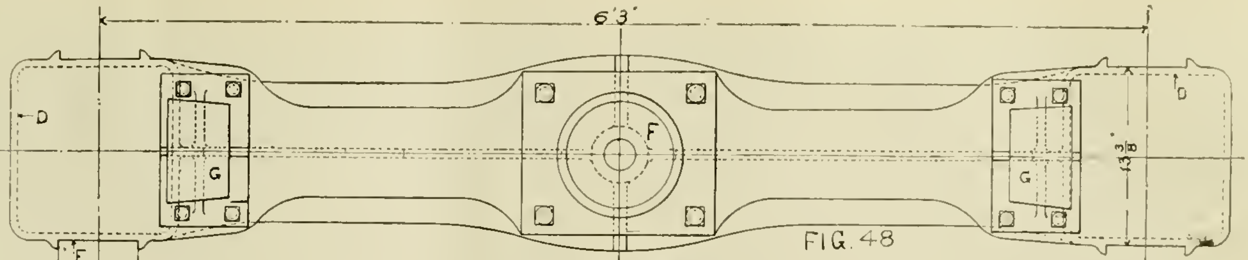
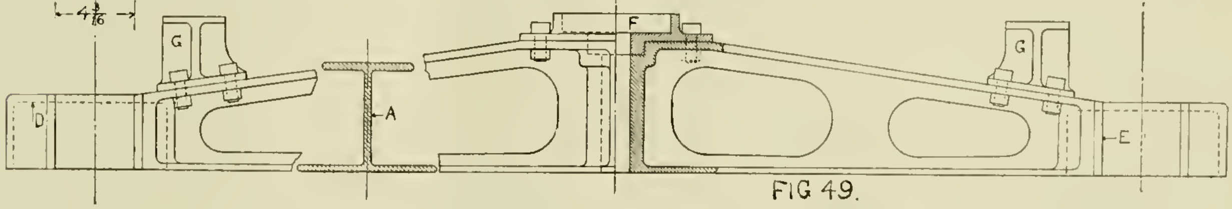
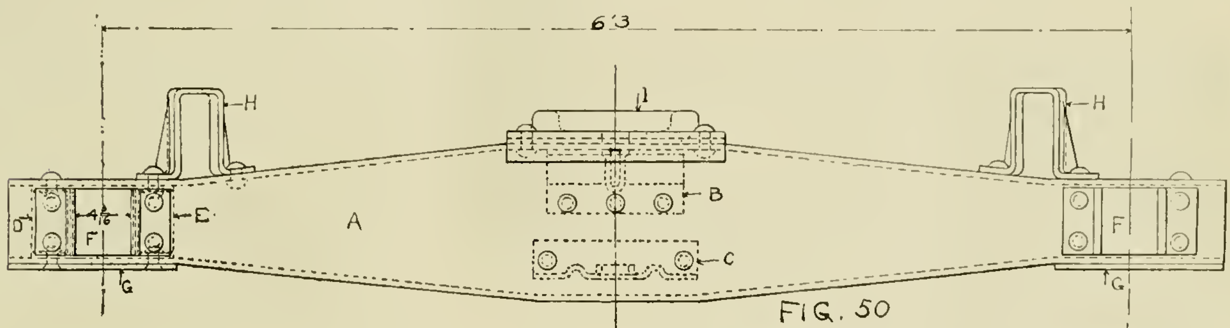
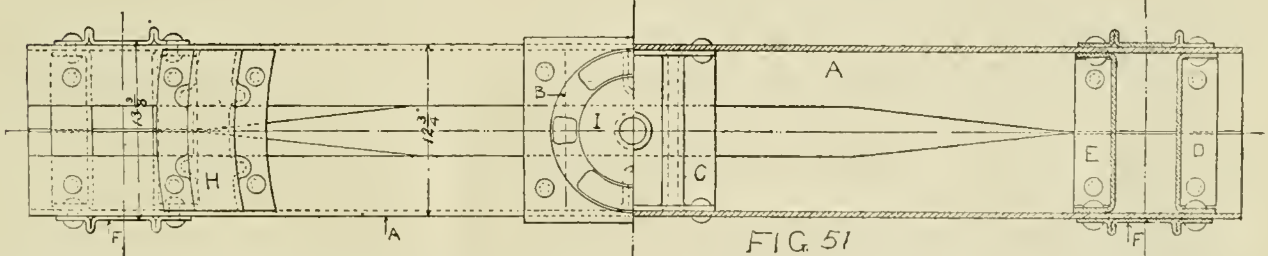


FIG 47









flat bars, steel castings and pressed steel have been used respectively for truck bolsters; and these will be described individually.

There is more or less diversity in the details of wooden truck bolsters, the cross section being the same on hardly any two roads, some using one solid piece of wood, some two pieces bolted together, and others again introducing flat plates, channel bars or I-beams, those without any iron stiffeners being trussed by rods, Figs. 43, 44 and 45 show a good form of the latter, which will fit the truck frame illustrated in the last issue. The bolster *AA* is made of oak, $8\frac{1}{2}$ by 13 inches in section, and is cut down to $6\frac{1}{2}$ inches deep at the ends, where it projects through between the arch bars rud column guiides. It is trussed by means of truss-rods *BB*, $1\frac{1}{4}$ inches in diameter, with the ends enlarged to $1\frac{5}{8}$ inches. The rods are bent to shape and then inserted in place through slots cut in the bottom of the bolster, which are filled up by pieces of wood, after the rods are in place. On the lower side of the bolster the rods pass under cast-iron posts *CC*, about 4 inches high, two to each rod; the ends of the rods pass through washers *DD*, which cover the ends of the bolster and take both rods. These washers are made of either cast or malleable iron or pressed steel.

To each side of the bolster at each end are bolted the bolster guide blocks *EE*, by means of three $\frac{5}{8}$-inch bolts, passing through the bolster and having double nuts. The bolster is gained out to receive the raised part of this casting, the corresponding depressed part working over the column guide bar, and keeping the bolster from moving laterally.

The truck center plate *FF* is bolted to the bolster by means of four $\frac{3}{4}$-inch bolts, and is provided with lugs or dowels and sometimes with flanges on its side to prevent its displacement and to relieve the bolts.

Different styles of center plates are in use which were explained, under the head of body bolsters.

The side bearings *GG* are made of proper height to allow a space of from $\frac{1}{4}$ to $\frac{1}{2}$ inch between the body and truck side bearings when the car is empty and on a straight track, and are fastened to the bolster by means of two $\frac{5}{8}$-inch bolts. Other styles of side bearings are in use, which have already been described under the head of body bolsters.

In Figs. 46 and 47 is shown a truck bolster made of bars of flat iron bent to form a truss. *A* and *B* are the upper and lower bars, made of $\frac{3}{4}$ and $\frac{5}{8}$-inch iron respectively, each being 12 inches wide. The bars are bent as shown, and are tied together by $\frac{3}{4}$-inch bolts passing through malleable iron distance pieces *C*, *D* and *E;* some of these bolts are also utilized to hold the centreplate and side-bearings. The lower bar is upset on the ends, forming lugs for the upper bar to bear against. There is considerable strain on the bolts in this construction, and it has been found necessary to make the fit in the holes a good one to prevent their breaking. The two bolts in the outer ends should be turned and driven in.

The ends of the bolster are provided with malleable castings *FF*, having flanges which guide the bolster in its vertical motion on the bolster column, and also have pockets on their lower sides for the bolster springs to rest in. Side bearings *GG* and center *H* are provided as usual.

Cast steel is used to some extent for truck bolsters, and the cross-sections having the maximum strength for the minimum weight are adopted, which are the channel bar and the I-beam sections, Figs. 48 and 49 showing one of the latter kind, the section being shown at *A*. The spring pockets *DD* and guides for the column bars *EE* are cast in one piece with the bolster and the center plate *F* and side bearings *GG* are sometimes also made part of the same casting, although usually they are bolted on, so that their height may be adjusted when it is necessary to change the height of the car. The center plate shown has a hub on the bottom, around the center-pin hole, which rests in a corresponding recess in the bolster, and thereby relieves the bolts of considerable strain.

The bolster shown in Figs. 50, 51 and 52 is made entirely of pressed steel, riveted together by ¾-inch rivets. The two sides *AA* are pressed in the shape of channels and are connected by means of center braces *B* and *C*, and end braces *DD* and *EE*. The bolster guide blocks *FF* are also made of pressed steel and riveted in place. A spring plate *GG* is riveted on the lower side of each end, where it rests on the bolster springs. Side bearings *H H* and center plate *I* of pressed steel are also riveted on and assist to tie together the two sides of the bolster.

(*To be Continued.*)

The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers.*

BY PROF. W. F. M. GOSS.

The experiments with which this paper is concerned were carried out a few months ago in the locomotive laboratory of Purdue University. They are here presented by a brief and very general description of the work, together with a discussion of some of its most significant results, and by two appendices which give the more technical descriptions, Appendix I dealing with the apparatus and methods employed, and Appendix II giving a summary of all observed and calculated data.

The problem to be studied by means of the experiments will be more readily appreciated if it is remembered that the boiler of any given locomotive is most efficient when worked at the lowest power practicable; that, is when the rate of combustion in its firebox is minimum. For the development of a higher power, the rate of combustion must be increased, and, as a result, the efficiency of the boiler is lowered.

The relation between the rate of combustion and the weight of water per pound of coal for the Purdue locomotive "Schenectady,' while using Brazil block coal, is shown by Fig. 1.† From this diagram it appears that when coal is burned at the rate of 50 pounds per square foot of grate per hour, eight pounds of water are evaporated for each pound of coal; while if the rate of combustion is increased to 180 pounds per foot of grate, the evaporation falls to about five pounds—a loss in water evaporated per pound of coal of nearly 40 per cent. This loss may be due to a failure of the heating surfaces to absorb properly the increased volume of heat passing over them, or to the imperfect combustion of the fuel upon the grate, or it may be due to a combination of these causes.

That a portion of the loss occurs along the heating surfaces hardly admits of question, since it is well known that any increase in the rate of combustion results in a rise in the temperature of the smokebox gases; but whether, under ordinary conditions, any considerable portion of the loss shown by Fig. 1 is due to imperfect combustion, has not been demonstrated,‡ and it is this question especially that the present paper attempts to treat.

The importance of the subject is emphasized by the varying practice of locomotive designers, who, in some cases, have so designed large boilers as to allow a large grate, while in others they have been content to use a grate of moderate size, upon which they have forced the combustion beyond limits which had hitherto been customary.

It will be seen that a separation of the losses which may occur at the grate from those which take place along the heating surface could not be accomplished by boiler tests alone, because the results of such tests give the combined effect of both these losses. There are two variables involved, and in order that either may be determined one must be given a constant value. In the tests described, action along the heating surface was maintained constant, while conditions at the grate were varied.

As a preliminary step, a number of tests were outlined in which the total weight of fuel fired was to be constant throughout the series, while the rate of combustion was to be made different for each test by changing the area of grate. It is evident that if the action at the grate were equally efficient during the several tests—that is, for different rates of combustion—this provision would cause the same volume of heat to pass over the heating surfaces of the boiler, and hence would produce the same evaporation and the same smokebox temperature. If, on the other hand, the combustion should prove less efficient for any one test than for others, a smaller volume of heat would sweep the heating surface, less water would be evaporated, and the smokebox temperature would probably be lower.

The outline provided for all observations usual in boiler testing, and, in addition to these, for a determination of the weight of fuel lost in the form of sparks, and for chemical analyses of the fuel used, of the sparks caught and of the smokebox gases. A more complete description of the apparatus used and the methods employed will be found in Appendix I.

The first test was run with the locomotive under normal conditions. The whole grate was covered with fuel, the throttle was fully open, the cut-off approximately 6 inches, and the load such as to make the speed 25 miles per hour. These conditions gave a rate of combustion of 61 pounds of coal per square foot of grate per hour.

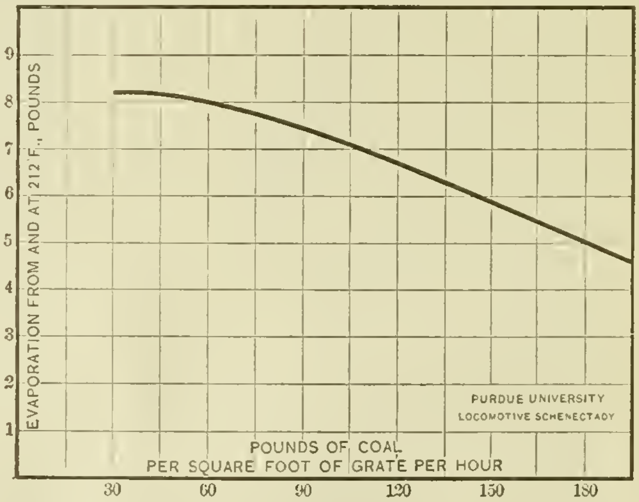


FIG. 1.

In preparation for the second test, one-quarter of the grate was made non-effective, or "deadened" by a covering of fire-brick. The exhaust tip was reduced, so that, while the engine was running as before and using approximately the same amount of steam, the same total weight of fuel could be burned on the reduced grate as in the first test had been burned on the whole grate. Trial tests were run until it was known that the changes made would permit the desired conditions to be maintained. The rate of combustion in this test was 84 pounds per square foot of grate area.

In preparation for the the third test, the grate surface was reduced to half its original area, and the rate of combustion was increased to 124 pounds per square foot of grate area; and during the fourth test only one-quarter of the original grate was used, the combustion in this case rising to 241 pounds per square foot of grate surface.

It should be evident from what precedes that the prescribed conditions were designed to make each test a duplicate of every other test, excepting in the matter of grate area, this being the one variable for the series.

The coal used in the several tests was of uniform quality, the the chemical analyses (Appendix II.) showing no greater variation than might occur in different samples from a single shipment. The maximum weight of coal fired per hour in any test was 1,087 and the minimum was 1,038, a difference of less than 50 pounds in more than 1,000, while the variation during three of the four tests does not exceed 1.2 per cent. of the weight fired. All firing was done by one man, the attendants engaged in taking the more important observations were the same for all tests, and

* From a paper read before the New York Railroad Club Sept. 17, 1896.
† Fig. 1 is reproduced from the Proceedings of the Western Railway Club, 1895.
‡ This question has been very ably discussed by Mr. W. H. Marshall, in an editorial which appeared in the January (1896) number of the *Railway Master Mechanic*.

all external conditions affecting the action of the boiler were uniform throughout the series.

The one variable for the series—namely, a different rate of combustion, was secured by keeping constant the weight of coal fired and by varying the area of the grate. There were burned each hour on each square foot of effective grate surface, 61 pounds during the first test, 84 during the second, 124 during the third and 241 during the fourth. These values more than cover the entire range of rates usual in locomotives.

Evidence of losses at the grate with increased rates of combustion is to be found in the record of water evaporated per pound of coal, which, for the several tests, is as follows:

1. Number of test	1	2	3	4
15. Rate of combustion; pounds of coal per foot of grate surface	61	84	124	241
50. Equivalent evaporation from and at 212 degrees Fahr.; pounds of water per pound of coal	8.26	7.87	7.52	6 67
Loss of evaporation in terms of the evaporation for test No. 1	....	4.7	9.0	19.2

In consideration of all the conditions governing the experiments, it would seem fair to assume that the decrease of 19 per cent. in the weight of water evaporated, a result which comes from increasing the rate of combustion from 61 to 241, is a loss which occurs wholly at the grate.*

The preceding paragraph exhibits a measure of the loss which occurred at the grate of the boiler tested, when the rate of combustion was increased above 61 pounds. A large fraction of this loss is to be accounted for by the escape of sparks, and it is significant that, as the sparks increase in volume, their heating value also increases. (Item 34.)

By reducing the weight of sparks to an equivalent weight of coal, on the basis of their relative heating value, it is possible to make the following comparison:

1. Number of Test	1	2	3	4
15. Rate of combustion	64	84	124	211
14. Total pounds of coal per hour	1,074	1,078	1,086	1,038
Total pounds of sparks per hour	61.5	95.1	128.6	176.3
Pounds of coal equivalent to spark losses per hour	46	77	111	161
Value of spark losses in per cent. of coal fired	4.3	7.2	10 2	15.5

According to popular judgment, the loss of heat by sparks has always appeared small; while the data show that under conditions which are now common, it may represent more than 10 per cent. of the fuel value of coal fired. It is evident, however, that these losses will in general depend very much upon the quality of coal and it should be noted that the Brazil block which was used in the tests under consideration is quite friable.

Without attempting a full discussion of the analyses of the smokebox gases (Items 37-41), attention may be directed to two important facts. These are, first, the large percentage of oxygen shown, indicating a supply of air greatly in excess of that required for combustion; and, secondly, the absence of carbon-monoxide (CO) in all excepting the last test.

All air admitted to the furnace in excess of that required for combustion is heated from the temperature of the atmosphere to that of the smokebox, and by this process heat is taken from the furnace. As the data show an increasing amount of air during the third and fourth tests of the series, it would appear that this cause must have operated to reduce the performance of the boiler as the rate of combustion was increased.

The presence of carbon-monoxide (CO) in the smokebox gases is accepted as proof of imperfect combustion. This gas, as already noted, occurs only in Test No. 4. It has long been supposed that its formation is due thick firing, and its failure to burn after it is formed to deficient air supply, or to a temperature too low to ignite it. Upon this theory, its presence in Test No. 4, and its absence in the other three, are difficult to explain.

In contradiction of the old theory, however, Herr R. Ernst† has recently shown that the amount of this gas (CO) formed in the combustion of carbon depends upon the temperature of the fire; that, as the temperature of the fire is increased, a larger proportion of the carbon is converted into CO, until under very high rates of combustion, or, more specifically, when the temperature of the fire is above 1,800 degrees Fahr., the first process of combustion is the entire conversion of the carbon into this gas. He has also shown that this gas will not burn, even in the presence of air, so long as its temperature is above 1,800 degrees Fahr.; it must be cooled before it will burn. Herr Ernst argues that, for high rates of combustion, there should be a rapid transfer of the heat liberated from the combustion chamber, in order that the carbon-monoxide formed may be sufficiently reduced in temperature to burn. This theory points to the possibility of heavy losses through the formation and non-combustion of carbon-monoxide in the locomotive firebox, in which very high rates of combustion are maintained, but the results of the Purdue experiments are reassuring. It must be admitted, however, that the relation of grate surface to firebox volume, during all but the first test, gave conditions which more nearly satisfy those prescribed by Herr Ernst than would exist had the same rates of combustion been maintained on a full grate. On the other hand, it may be urged that the rate of combustion maintained in Test No. 4 was higher than any which can be found in practice, a condition which would tend to neutralize the advantage of a large firebox. But, theory aside, the fact remains that the tests show very small losses by imperfect combustion, even when the rate of combustion is highest.*

CONCLUSIONS.

The results show that the most efficient furnace action accompanies the lowest rates of combustion; and while the precise relationships established by the experiments may not hold for fuel which is different from that employed, nevertheless they enforce the general conclusion that very high rates of combustion are not desirable, and, consequently, that the grate of a locomotive should be made so large that exceptionally high rates will not be necessary. They emphasize, also, the importance of spark losses, which, during the experiments under discussion, practically equalled in value all other losses occurring at the grate.

Leaving the conditions peculiar to the experiments, and assuming that the results obtained from them may be applied to the locomotive "Schenectady," when working under normal conditions, we find that the losses in evaporative efficiency which occur when the rate of combustion is increased above 50 pounds may be accounted for approximately as follows: The relation between the rate of combustion and the water evaporated per pound of coal, under normal conditions, is represented by the line $a\ b$, Fig. 2. If it could be assumed that the heat developed in the furnace would be absorbed with the same degree of completeness for all rates of combustion, the evaporation would rise to the line $a\ c$; if in addition to this it could also be assumed that there were no spark losses, the evaporation would rise to the line $a\ d$; finally, if, in addition to these, it could be assumed that there were no losses by the excessive admission of air, or by incomplete combustion, then the evaporation would remain constant for all rates of combustion, and would be represented by the line $a\ e$.

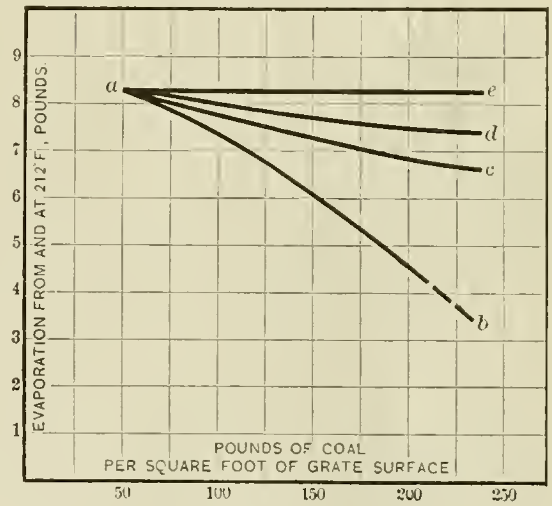


FIG. 2.

That is, with the boiler under normal cond...ns, the area $a\ b\ c$ represents the loss occasioned by deficient heating surface, the area

* The fact that the plan of the tests did not allow the boiler to develop the same power during all tests, may give rise to a question concerning the accuracy of this statement; it may be said that a portion of the effects produced is due to changes in power. Against such an objection, it may be urged that changes in power were comparatively slight, and it can be shown that their influence would diminish, rather than increase, the difference in the observed results. It is, therefore, safe to say that the losses at the grate are not less than those given.

† "The Principles of Combustion," a paper by R. Ernst, published as an inaugural dissertation at the University of Giessen, Hamburg, 1892. (See *The Engineer*, London, Aug. 4, 1893.)

* In a list of nine analyses of locomotive smokebox gases, selected by Mr. Kent from a large number made by Mr. P. H. Dudley, three exhibit CO. The amount varies from one per cent. to 2.5 per cent.

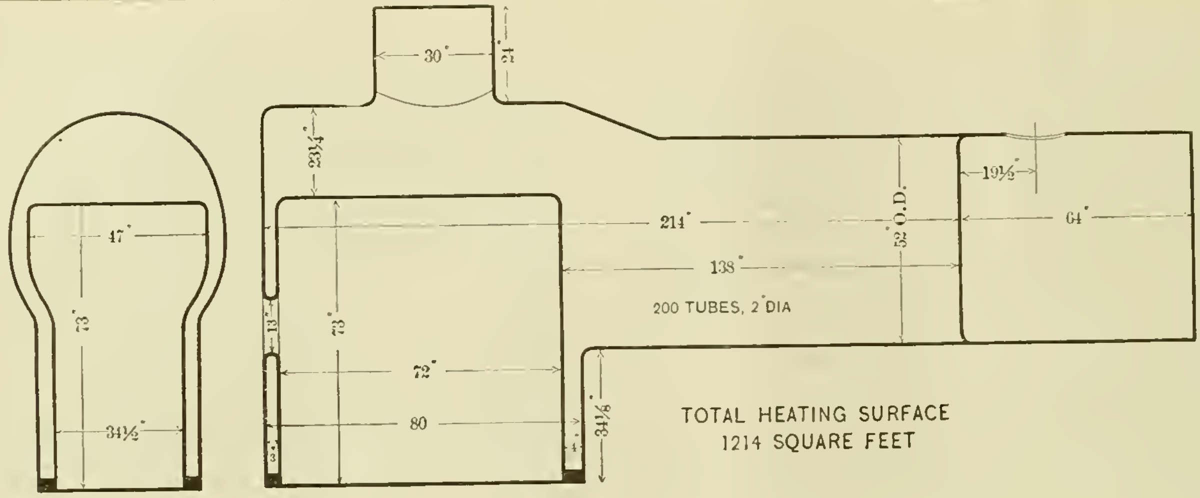


FIG. 3.

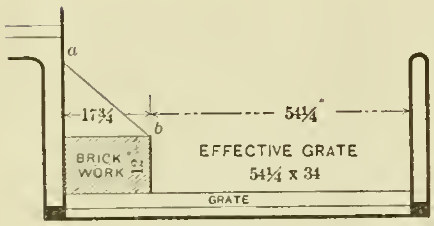


FIG. 4. TEST 2.

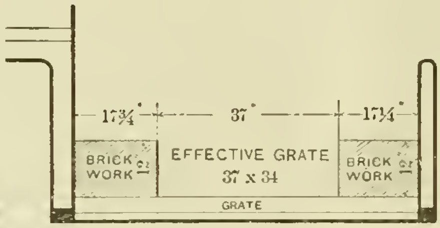


FIG. 5. TEST 3.

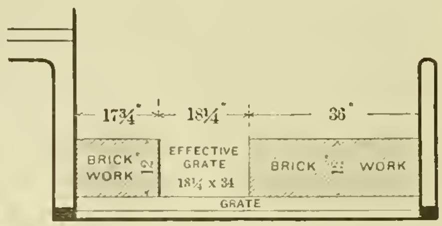


FIG. 6. TEST 4.

Boiler and Grates Used in Testing Efficiency of Different Rates of Combustion.

a e d that occasioned by spark losses, and the area *a d e* that occasioned by excessive amounts of air and by imperfect combustion.

APPENDIX I.

APPARATUS AND METHODS.

The experiments discussed in the foregoing paper were conducted by Mr. Alfred R. Kipp, in conjunction with Mr. Richard A. Smart, who, as Instructor in the Engineering Laboratory, had immediate charge of the work. All chemical analyses were made by Mr. Charles D. Test, under the direction of Prof. W. E. Stone, in charge of the Purdue Chemical Department.

The apparatus employed constitutes a portion of the permanent equipment of the locomotive laboratory of Purdue University, but this experimental locomotive plant has been so many times described that it does not in this place require special description. The locomotive is of the eight-wheeled type, with 17 by 24 inch cylinders, and weighs 85,000 pounds. The boiler, with which the present work especially concerns itself, is shown in outline by Fig. 3.

The deadening, which was employed to cut out portions of the grate, was of brick laid up in fire-clay, the effect being to make the covered portions of the grate as nearly air-tight as possible. The material extended across the breadth of the firebox, the sections of the grate covered being disconnected from the rocking mechanism, so that the remainder could be used with undiminished effect. Its distribution during the several tests is shown by Figs. 4, 5 and 6, respectively.

Early in the second test, ash piled up on the deadening, as indicated by the line *a b*, Fig. 4; but as the accumulation did not reach the lower tubes, it was not dislodged. At the end of the test, everything in the firebox which was not coal was credited to ash. During the third test there was less of this deposit, and during the fourth still less, an effect probably due to the presence of a stronger draft.

The thickness of fire for each test was not greater than was necessary to the easy maintenance of the steam pressure. The firing was always at regular intervals, and usually only three shovelfuls were thrown in at one time. In the fourth test the thickness of the fire equaled that of the deadening (Fig. 6).

The samples of smokebox gases for analyses were drawn from a point near the center of the smokebox. Ten minutes were occupied in obtaining the sample, a period sufficiently long to cover all conditions of fire.

The smokebox temperatures were obtained by means of a Le Chatelier pyrometer, an instrument constructed on the thermopile and galvanometer principle, and which, for comparative work, is very reliable. The differences in temperature recorded are probably correct within less than one per cent.

The weight of sparks or cinders passing the heating surface is the sum of those caught in the front end of the locomotive and those passing out at the top of the stack. The sparks which accumulated in the front end were easily collected and weighed. Of those which passed out of the stack, a portion only were collected, the sample being so chosen as to serve as a basis from which the value of the whole could be estimated. The apparatus employed in this latter process is shown by Fig. 7. It consists of an inverted U-tube of galvanized iron, securely fastened to a movable frame, by means of which the tip, which constitutes one extremity of the tube, can be projected across the top of the locomotive smokestack. The outer end of the tube may thus be made completely to intercept a portion of the stream issuing from the

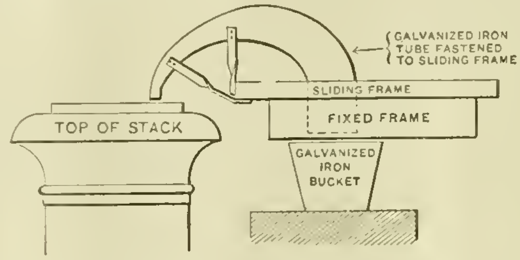


FIG. 7. SPARK TRAP.

stack, and the continuous action of this stream is sufficient to drive the intercepted portion through the tube and out at the other end. The gases passing the tube bear the sparks on their current, and they are collected in a bucket set to entrap them. Reference marks upon the sliding and the fixed frames permit the tubes to be placed in definite locations relative to the center of the stack. This device, when in service, catches everything excepting the lightest soot, which is allowed to escape unaccounted for.

After assuming the cross-section of the stream issuing from the stack to be cut up, by a series of concentric circles, into one circular and several annular areas, as shown by Fig. 8, the small end of the

U-tube was placed in the position marked I and held there for 30 minutes, the sparks collected during this interval being credited to this position. The tube was then moved to the position II, where it remained for another period of 30 minutes. In like manner, it was made to occupy, successively, the positions III and IV, and also the positions I_1, II_1, III_1 and IV_1, the weight of sparks caught during each interval being credited to the corresponding position occupied by the small end of the tube. This end of the tube had an area of one square inch, and it was assumed that the average weight of sparks passing the tube while in the positions I and I_1, would be the same as that passing every square inch in the annular space in which these positions are located. For example, the outer annular area, in which I and I_1 are located, contains 88 square inches. If, in half an hour, 0.5 pound was collected by the tube in the position I, and in another half hour 0.3 pound was collected from the position I_1, the sum of these two weights, or 0.8 pound, collected during a period of one hour would be the average weight per square inch per hour collected from the two positions, and the weight for the whole outside annular area would be 0.8 times 88, the number of square inches, or 70.4 pounds per hour. A similar experiment and calculation gave the weight per hour delivered by each of the other annular areas II and III, and by the circular area IV. The sum of these separate determinations was assumed to be the total weight of sparks per hour delivered from the stack.

Other accessory apparatus employed was such as is commonly used in boiler testing, and therefore need not be described.

The engines of the locomotive were not involved in the tests, excepting as they served to shake the boiler, to furnish draft and to consume the steam generated. While the speed was varied slightly in different tests as a means by which desired rates of combustion might be the more readily secured, it was approximately 25 miles per hour for all tests. The running for each test, therefore, was equivalent to 150 miles.

In running the tests, regular observations were made at the beginning, and at five-minute intervals thereafter, giving 73 series of observations, upon the average of which the data are based. Exceptions to this rule are, however, to be made in the case of the spark record, to which reference has already been made, and in the case of the draft record, which was obtained by readings each minute during the first 20 minutes of every hour.

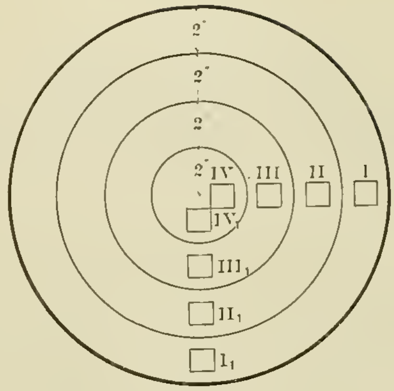


FIG. 8.

APPENDIX II.

OBSERVED AND CALCULATED DATA.

1. Test Number	1	2	3	4
2. Month and day (1896)	Feb. 8.	Feb. 11.	Feb. 15.	Feb. 22
3. Duration of test, hours	6.	6.	6.	6.
4. Approximate portion of whole grate used	Full.	Three-fourths.	Half.	One-fourth.
5. Exact area of effective grate, square feet.*	17.50	13 01	8.74	4 31
6. Barometric pressure, pounds	14 41	14 43	14 34	14 47
*Analysis of Coal.**				
7. Per cent. fixed carbon	49.05	51.84	51.09	51.59
8. Per cent. volatile matter	40.29	39 00	38.93	38.87
9. Per cent. combined moisture	3.15	3.02	2.35	3.44
10. Per cent. ash	6.91	5.54	7.63	6.10
Coal [Brazil Block].				
11. Pound fired	6522.	6628.	6716.	6328.
12. Weight of water in each pound of coal fired	0.012	0.016	0.030	0.012
13. Pounds of dry coal for test	6443.	6522.	6514.	6227.
14. Pounds of dry coal per hour	1074.	1087.	1080.	1038.
15. Pounds of dry coal per hour per square foot of grate	61.4	83.5	124.2	240 8
16. Pounds of combustible for test	5792.	5921.	5856.	5635.
17. Percentage of fixed carbon in coal, dry and free from ash.	56.	57.	57.	57.
18. Approximate number of B. T. U. per pound of combustible.	13800.	14040.	14040.	14040.
19. Approximate number of B. T. U. per pound of dry coal	13000.	13000.	13000.	13000.
20. Theoretical evaporation from and at 212° per pound of dry coal	13 46	13.46	13 46	13 46
Ash.				
21. Pounds of dry ash in ash-pan for test	446.	396.	297.	164.
22. Pounds of ash in coal fired as shown by analysis of coal	445.	361.	497.	380.
23. Pounds of ash by analysis, minus pounds found in ash-pan	—1.	—35.	200.	216.
*Analysis of Sparks.**				
24. Per cent. of fixed carbon	61.74	64.88	71.32	76.44
25. Per cent. volatile matter	4.36	4.16	3.45	3.29
26. Per cent. combined moisture	1.82	1.82	1.66	1.86
27. Per cent. ash	32.08	29.14	23.57	18.41
Sparks.				
28. Pounds caught in front-end during test	75.	213.	494.	566.
29. Pounds passing out of stack for test	294.	358.	278.	492.
Test Number	1	2	3	4
30. Total pounds of sparks for test.	369.	571.	772.	1058
31. Pounds of sparks per square foot of grate per hour	3.5	7.3	14.7	41.0
32. Pounds of combustible in sparks for test	242.	395.	576.	837.
33. Percentage of fixed carbon in sparks dry and free from ash.	94.	.94	95.	96.
34. Approximate B. T. U. per pound of sparks	9870.	10360.	11200.	11880.
35. Pounds of coal equivalent in heating value to one pound of sparks	0.75	0.80	0 86	0.91
36. Pounds of coal equivalent in heating value to total weight of sparks for test	277.	457.	664.	963.
*Analysis of Smoke-Box Gases.**				
37. Per cent. carbon dioxide	5.25	6.25	4 80	1 80
38. Per cent. heavy hydro-carbons.	0.50	0.40	0.40	0.50
39. Per cent. oxygen	12.15	11.80	14.60	18.70
40. Per cent. carbon monoxide	0.00	0.00	0.00	0.55
41. Per cent. nitrogen	81.90	81.55	80.20	78.45
Other Smoke-Box Data.				
42. Diameter of Double Exhaust tip	3.	2.75	2.35	1 75
43. Draft in inches of water	2.2	2.5	3 3	5.6
44. Temperature of smoke-box, degrees F	647.	629.	610.	500.
Water and Steam				
45. Pounds of water delivered to boiler	44756.	43081.	40710.	43770.
46. Temperature of feed, degrees F.	54.0	53.0	53.5	52.7
47. Boiler pressure, by gage	129.4	127.2	127.2	129.1
48. Quality of steam in dome	0.982	0.981	0.984	0 983
Evaporation.				
49. Pounds of water evaporated per pound of dry coal	6.94	6.60	6 30	5.58
50. Equivalent evaporation from and at 212° F	8.26	7.87	7.52	6.67
Horse Power.				
51. Horse power of Boiler	257.	248.	226.	201.
52. Horse power per square foot of grate	15.	19.	26.	47.
Approximate Efficiency.†				
53. Ratio of heat developed in the furnace to heat absorbed by water	0.61	0.59	0.56	0.50

* All chemical analyses were made under the direction of Professor W. E. Stone, by Charles D. Test, A. C.

* All chemical analyses were made under the direction of Professor W. E. Stone, Charles D Test, A. C.

† The efficiency is approximate only, since the heating value of the coal is only approximately known. Since the same coal was used for all tests, there can be no error in using this factor for purposes of comparison within the limits of the present series of tests.

Our esteemed contemporary, the *Iron Age*, has removed its offices from 96–102 Reade street to 232–238 William street, New York.

The offices of the Colliery Engineer Company, proprietors of *The Colliery Engineer and Metal Miner*, *Home Study*, and the International Correspondence Schools, in the Coal Exchange Building, Scranton, Pa., were partially destroyed by fire on Sunday morning, Aug. 30, 1896. Fortunately the printing plant was in another building, and the reserves of all instruction and question papers, drawing plates and other supplies and stationery used in the schools in still another building, so that its business will not be seriously interfered with.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY BY R. M. VAN ARSDALE,

MORSE BUILDING............NEW YORK.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

OCTOBER, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

NOTICE.

To manufacturers and business men who want to prepare at once for the improvement in business that will result from the defeat of free silver on Nov. 3d, and who yet hesitate to incur any new obligations at present, we make the following proposition:

To those who make advertising contracts with us before Nov. 3d we will agree to publish their advertisements for one year on the condition that if Mr. McKinley is elected President they will pay for them at the regular prices, but if Mr. Bryan is elected, their advertisements in this journal will be free of charge for the period covered by their contracts.

We have enough faith in the result of the campaign of education now going on, in which the railroad technical press is taking such a creditable part, to make this offer to those who still hesitate to resume business activities.

BUSINESS, HONESTY AND PATRIOTISM.

If the present unsatisfactory condition of business were the temporary result of political agitation and of politics only, we would not feel that it was the province of this journal to take sides or express any opinion on the issues involved. But the present crisis in our national and individual affairs has been brought about not by politics but by an avowed determination of persons ignorant of the natural laws of finance and commerce to overthrow our present coinage system and (if they get the chance) launch this country upon a dangerous sea of financial experiment and theory which can only end in disaster and ruin. The mere announcement of such a programme has applied the brakes to all enterprise and trade expansion, and brought to a standstill everything that could stop. The result would have been the same if any other party of sufficient power had advocated free coinage of silver, for in commercial and financial affairs, just as truly as in railroading, a danger signal is an order to stop, irrespective of who set the signal.

Most of our readers are employed by, or are interested in, railroads and industrial and manufacturing enterprises. If the proposed free-silver legislation is ever carried into effect their interests will be hit promptly and hit hard, and that, too, without any definite gain to the country at large, but with certain disaster. We do not need to tell our readers that their interests are already affected. Railroad reports for the year ending June 30, 1896, taken as a whole, show that railroads had recovered from the depression of the two or three years immediately preceding, and were enjoying a business that had seldom, if ever, been exceeded in their history. Their purchases of material were heavy, and concerns supplying it were prosperous. The great volume of the transportation business indicated returning prosperity in all directions.

The first of the political conventions gave an added impetus to business because it declared for a gold standard. One of the largest builders of machine tools told us last week that the orders his firm received during the month of that convention were the largest in its history. Then followed the other conventions, with their platforms threatening the stability of our currency, and even of the government itself. The danger signals were set and things stopped moving. They stopped so quickly that, to quote again the experience of the concern above mentioned, it received that month just one-fifth as many orders as in the preceding month, and now it has none.

Our readers are practical men who in technical affairs refuse to base their actions on theories not supported by facts. In the present campaign against sound money, many glowing promises are given and attractive theories promulgated that are not supported by facts. We don't for a moment believe that they will be entertained.

It is claimed that under the free coinage of silver at a ratio of 16 to 1, silver will rise in bullion value to $1.29 per ounce, and that our gold and silver currency will circulate at equal value as now. If such an absurdity could be brought to pass what would be accomplished? Simply that the silver-mine owners of the world who are now selling 175,000,000 ounces of silver annually for about $114,000,000 and realizing a handsome profit thereby, would receive for this bullion $225,750,000, or an additional profit of $111,750,000; furthermore, as if that were not enough for these favored persons, the taxpayers in these United States will generously pay the expense of coining as much of this bullion as the owners of it desire to have coined. After coining it, the money will be placed in the hands of the bullion owners and they will say how and when it goes into circulation. Does any one for a moment suppose that those millions of additional profit would ever reach the pockets of the great body of our citizens working for salaries and wages on any more favorable terms than the present dollars do? If not, why should we vote these enormous profits into the pockets of any one class of citizens or of foreigners?

But as the price of silver will not rise to the value of $1.29 per ounce—for the pages of history bristle with facts that say it will not—then the proposed legislation is positively dishonest. For us, either as a nation or as individuals, to borrow 100-cent dollars and to deliberately pay back our obligations in dollars worth only 50 cents, is so rankly dishonest that we do not believe the citizens of this nation, whose proud record is that it has always stood for fair dealings among the nations of the earth, will ever permit such methods to come to pass.

We have too much faith in the intelligence of our citizens to believe that the result in November will be anything else than a free-silver funeral. And after burying this fallacy so deep that it will never rise again, we can then look forward to years of prosperity for all.

The use of a leading four-wheeled truck under express locomotives is gaining favor in England and on the continent, some believing it the safer construction, while others, not admitting the need of it, use it for the reason that they find the engineers make better time because of their confidence in it. The report on the accident which occurred last May on the North British Railway also contains an argument in favor of the leading four-wheeled truck. The accident was caused by the expansion and consequent lateral deflection of the rails by the excessive heat of the sun at that time. Lieutenant-Colonel Yorke, reporting to the Board of Trade, says: "The fact that the engine did not leave the rails, although the rest of the train did, may probably be attributed to the flexibility imparted to the engine by the leading bogie, which was able to adjust itself to the irregular curvature of the lines produced by the expansion of the rails, whereas the tender, with its six wheels and rigid wheelbase, was most probably the first vehicle to leave the metals and dragged the rest of the train after it."

The new cruiser *Brooklyn*, built for the United States government by the Cramps, and illustrated elsewhere in this issue, has undergone her official trial trip and developed a speed of 21.9117 knots per hour. This was the average speed over the entire course of more than 80 miles, and the maximum speed between two buoys was 22.90 knots. This remarkable performance is a source of gratification to both the builders and the government. It speaks well for the ability of the builders and the designers, and it is calculated to awaken feelings of justifiable pride in the hearts of patriotic citizens. Such excellent records also have a money value, not alone to the builders, who in this case earned $350,000 in premiums, but to the country that foots the bills. The progress of naval construction is so rapid nowadays that vessels which do not come up to the highest standards of speeds and fighting power for their respective classes will soon become obsolete and be no match for later additions to other navies. The production, therefore, of vessel after vessel of speeds approximating that of the *Brooklyn*, or of fighting power and resistance to projectiles like that possessed by the *Indiana* and *Oregon*, puts the United States in possession of men-of-war that to-day excel similar vessels in the other navies of the world, and that are sure to be up to date for many years to come. Thus the tax-paying citizen is assured that for every dollar put into these vessels the best possible return is received.

From the part of a discussion before the London session of the International Railway Congress published on another page, one can see that much ignorance exists in Europe in regard to many details of American railroad practice. From the discussion on slide valves for express locomotives it would appear that European engineers are exceedingly anxious to use balanced valves, and are only deterred from so doing because of the absence of a satisfactory method of construction. And yet the universal practice in this country is to employ balanced valves on such engines, and they are almost all of the Richardson type. Practice here has become so uniform that it is conclusive evidence of the satisfaction given by this kind of balanced valve in regular service. Before European engineeers get discouraged in their search after a good balanced valve, they had better investigate American practice. There is so much incredulity in the minds of these gentlemen regarding the statements of American doings, fostered probably by the spread-eagle style of our daily press, that it may explain their neglect to investigate our practice. This incredulity is well illustrated by what Mr. H. S. Haines said in his recent address to the American Railway Association. He stated that "when the American delegates spoke at the London Congress of handling 50 or 100 trains a day, and 30,000 or 40,000 cars a month over a single track, the statements were evidently received as specimens of American brag."

The tests of a 300 horse-power De Laval steam turbine to be found on another page are of considerable interest, not only from the low steam consumption at full load of 17.348 pounds per brake horse-power, and 19.275 pounds per electrical horse-power, but also from the fact that at 89 per cent. of full load the performance was equally good, while at 56 per cent. the water consumption was only 20.22 pounds per electrical horse-power, and at 18¼ per cent. of full load it had only risen to 27.35 pounds per electrical horse power. This excellent performance and the small space occupied by the turbine are greatly in its favor, and while the first cost may now be as great per horse-power as for a reciprocating steam engine, there would seem to be a reasonable prospect for a great reduction in the price of the turbine. Against these advantages, actual and prospective, must be placed the high speed of rotation, necessitating gearing that may prove expensive to maintain. The large turbines whose tests are recorded in the article already alluded to, should, in the course of a few years, furnish some valuable experience on this point. Should the gearing for large powers prove subject to break down and expensive to mantain, the turbine may be limited in its usefulness to small powers or to the driving of machinery running at such speeds as not to require the gears at all. It is of interest to note that in the case of dynamos, it may be possible to do this in the not distant future, for at least one large firm manufacturing dynamos and motors is at work upon a motor that will run at a speed of 10,000 revolutions per minute. This moter, if it can be successfully constructed, will be used by the United States government on men-of-war to start the propelling machinery of Howell torpedoes just before they are fired from their tubes. This torpedo is propelled by the energy stored in a small fly-wheel inside of it, made to revolve at a speed of 10,000 revolutions, and at present a steam turbine is the only motor of simple form that is available to rotate the fly-wheel at that speed. But there are serious objections to steam pipes leading to the vicinity of every torpedo tube on the vessel, and hence there is an earnest call for a high-speed motor. If this demand is met it may show the way to the construction of high-speed dynamos capable of being driven directly by turbines.

THE USE OF BUFFER BLOCKS WITH VERTICAL PLANE COUPLERS.

When the railroads of this country began the use of vertical plane couplers in freight service, many cars were equipped with buffer blocks for the better protection of the draft gear and the link and pin couplers then in use. With the introduction of the new couplers the use of these buffer blocks was in a number of cases abandoned and the more expensive couplers allowed to take all the shocks of service without protection. Many railroad officials have thought this policy a mistaken one, but there was one good defense for it in the fact that the face of the vertical plane coupler is three inches further from the face of the dead wood than the face of the link and pin bar, so that when couplers of the two types were brought together the buffer blocks were non-effective. If two vertical plane couplers were coupled together the blocks would be as effective as when two link and pin couplers were united, but as in the early days of the introduction of the M. C. B. couplers their number was small compared with the old type, it is evident that such buffer blocks as were placed on cars so equipped would seldom be effective in relieving the draw gears of buffing strains. Consequently there was reason in the argument that they could be omitted until such time as the M. C. B. couplers became numerous enough to warrant their use.

It is believed by many that that time has now come, but unfortunately, in the period when the number of roads using buffer blocks diminished, many persons appear to have lost sight of the fact that under the right conditions the blocks would afford a much-needed protection to the couplers; hence it is not easy to arouse an interest in them now. Those who are using them are, however, fully convinced as to the wisdom of the expenditure, for they find the resulting saving in the repairs to draft gears to be remarkable. On a road in the East handling at one point several thousand of its own cars every one of which is equipped with the buffers, and about as many hundred cars of a connecting line not equipped with the buffers, the aggregate repairs to the draft gears is more on the foreign than on the home cars, notwithstanding that the latter are nearly ten times as numerous. The cars are all in the same coal traffic, are quite similar in construction, and there does not seem to be any reason for the difference in the cost of repairs except the absence of buffers in the one case.

It does not seem unreasonable to conclude that when all cars are equipped with M. C. B. couplers, the use of buffer blocks would permit a lighter construction of the coupler so that part of the metal now put in the coupler to meet buffing strains, will be transferred to the buffer blocks, where it can better perform its proper function of protecting the draft rigging. If this is the case, the actual cost of the buffers will not be as great as might appear. Certain it is that the method of taking the buffing shocks upon the bracket of the coupler, over an area so small as to rapidly break down the fibers of the end sill and to bend any plate or angle iron used to protect the sill, and at an average distance of at least 4½ inches above the center of the stem, by which leverage fractures through the stem back of the head are deliberately invited, is wrong in principle, and it is believed that it will ultimately be changed.

The advantages arising from the use of buffer-blocks seems to be so clear that discussion is almost unnecessary. The facts are all in favor of those who use them. But it may not be out of place to call attention to the necessity of preserving the standard distance of 10½ inches from the face of the deadwood or sill to the inner face of the hook, or 8¾ inches from the horn of the coupler to the hook. That these figures have not been adhered to is evident from investigations made by several parties. We have before us the results of two sets of measurements made on a large number of different makes of couplers, one set being taken in the West and another in the East. Altogether 35 different kinds of M. C. B. couplers were measured. In some cases the two measurements of one kind of coupler agreed, in others they did not, but giving the manufacturer the benefit of the measurement nearer to the standard, the result may be stated as follows:

1	coupler	measured	8	inches	from	knuckle	to	bracket.
1	"	"	8¼	"	"	"	"	"
1	"	"	8⅜	"	"	"	"	"
2	"	"	8½	"	"	"	"	"
17	"	"	8¾	"	"	"	"	"
1	"	"	8⅞	"	"	"	"	"
8	"	"	9	"	"	"	"	"
2	"	"	9¼	"	"	"	"	"
1	"	"	9½	"	"	"	"	"
1	"	"	9¾	"	"	"	"	"

It might be inferred that the 17 couplers which conformed to the standard included all the couplers extensively used, but such is not the case. Many of the well-known couplers conform to standard, but among the couplers that are over size are a number of well-known bars. The importance of making all couplers conform to the standard in this respect is so evident that surely the lack of conformity need only be pointed out to be remedied. The couplers that measure from 9 to 9¾ inches between the points mentioned will not permit the buffers to become operative until the sill or draft-rigging have been driven in sufficiently to damage and weaken them materially. Hence with such couplers those who apply buffers fail to get the benefit of them, and those who do not employ them would have the same trouble if at any time within the life of those couplers they should change their practice and apply the buffers. Manufacturers may have already altered their patterns to conform to the standard, but regular inspection on this point is desirable.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

II.

The admirable paper by Professor Goss, which was read and discussed at the meeting of the New York Railroad Club, on Sept 17, and which is reprinted on another page, gives fresh interest to the above subject, the discussion of which was commenced last month. At the meeting referred to the observations took a somewhat wide range, and were not confined alone to the points brought out in the paper, and in reality embraced a good deal of what is implied by the above title. It has always been known that very high rates of combustion are not only not economical, but are very wasteful, but Professor Goss' investigation have established this fact on what seems to be complete scientific proof. But another fact was also brought out in the discussion, which was that in burning bituminous coal if very large grates—such as are used in the Woolten firebox--are employed, that greater economy resulted by covering part of the grate with fire-brick or dead-plates than was attainable with the whole grate open. The demonstration of this fact however, is not as complete, as that presented by Professor Goss. The inference, however, is that while a grate may be too small—and probably most of these now in use are not large enough for economy—yet it is possible to have too much grate surface as well as too little. An average consumption of fuel of 100 pounds per square foot of grate per hour is not unusual—for light trains it is much less. The minimum consumption, probably, is often below ten pounds per square foot per hour. Supposing that the size of the grate was doubled, then the minimum might be less than 5 pounds. The lowest rate of combustion tested by Professor Goss was 61 pounds. It is to be regretted that he did not try the results on evaporation with much lower rates. With the present construction of grates, the question is, what size will give the best average results. A grate of a certain size might be wasteful with very high rates of combustion, but be economical when the engine was not working very hard. On most roads it is only during very short periods of time that locomotives must exert their maximum power. During much the greatest part of the time they are at work the consumption of coal is only at very moderate rates. As the conditions of working are constantly varying, it would seem to be desirable to have a grate whose size could be increased when the engine is working hard, and diminished when the demands are not so great.

Reference has been made in these columns heretofore to an engine of the Columbia type, which Mr. Rhodes, of the Chicago, Burlington & Quincy Railroad, had built, as a sort of experimental engine, to test that form of locomotive, and which was illustrated in the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for last December. As shown from the illustrations and description of that engine, which were then published, its two driving axles and wheels are in front of the firebox. The latter could, therefore, be made as wide as might be desired, and as deep as the trailing wheels below it would permit. In reality its inside dimensions were 8 feet 10¾ inches long by 5 feet wide. This engine, we learned some time ago, was showing a very marked economy over other engines of similar capacity on the road on which it is running, as we ventured to predict it would.

At the time it was illustrated we called attention to the theory advanced by Mr. Siemens that combustion is arrested when flame comes in contact with any solid substance, as is illustrated by inserting a wire into an ordinary gas flame. His inference was that it is desirable in all furnaces to keep the flame out of contact with the sides, ends and top of the firebox as long as possible, or until the process of combustion is completed. From this the deduction was drawn that the ideal form for a firebox would be a sphere or a cube—or, in other words, that its length, breadth and height should at least be approximately equal. A very common area of grates of locomotives is from 20 to 25 square feet. In Mr. Rhodes' engine he has nearly 45. Our prediction was based upon Mr. Siemens' theory, and also on our somewhat vague belief in what Professor Goss has since proved by his experiments. The deduction—which has since been confirmed by actual experience—was made from purely scientific data. It was an evolution of science and not of practice, and illustrates the value of science to railroad companies.

At the meeting of the Railroad Club, which has been referred to, a letter was read which was written by Professor Ostwald, a distinguished German chemist, to a fellow professor in England, in which he describes the means adopted in Germany which has enabled manufacturers in that country to compete successfully with Englishmen. Referring to his own specialty, Professor Ostwald said:

"Each large work has the greater part of its scientific staff—and there are often more than 100 Ph. D.'s in a single manufactory—occupied, not in the management of the manufacture, but in making inventions. The research laboratory in such work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability, they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years."

Commenting on this, the New York *Evening Post* says:

"Is it any wonder that by such methods Germany has come to control the fine chemical markets of the world? By her superiority in this respect alone she is able silently and without any legislation to lay a tax upon almost every industry in every country. German manufacturers have come to a clear understanding of the commercial importance of science. Not long ago one of them offered a university professor a very large salary simply to come into his works and make experiments regarding the practical use of certain scientific methods which the professor had been developing. This close relationship between science and industry is good for both. It puts the best trained and highest inventive power at the service of manufactures, and it also furnishes the scientist not only with new openings for a livelihood, but with wide opportunities for research."

Might it not be wise for some of our railroad companies to follow the example of the German chemists?

In an article published in the AMERICAN ENGINEER of December, 1894, it was shown that in the *best* performance of locomotives the fuel consumption is *only half* that of the *average* performance on well-managed roads. A very considerable economy would therefore seem to be possible if railroad companies would take some such steps as the Germans have taken to avail themselves of the greatest economies possible. Referring to the letter quoted the New York *Post* says further:

"Its significance was at once preceived. Here was something deeper and more powerful than tariffs. Here was a frank disclosing of the hiding of German power as a competitor for the world's commerce, with the unavoidable inference that there was but one way to rival it—not by laws or diplomatic manœuvres, but by meeting knowledge with knowledge and skill with skill."

There is probably no general subject which is now receiving so much attention from railroad managers as that of economy of operation. In many cases this has been a matter of life or death, or "to be or not to be"—in the hands of a Receiver.

To show how this subject appears to a person who regards the subject from the monetary side alone, the following quotation from the financial article of the *New York Times* of Sept. 20 is reprinted. The writer of the article says:

"That the St. Paul railroad managers have but recently discovered how to work their road more cheaply than any other granger road, and far more cheaply than the Lake Shore road, or the Pennsylvania system, not to speak of other large systems; and that this knowledge has been progressively acquired and applied, will appear from the following brief table:

Year.	Ratio.	Gross Earnings.
1893	65.19	$33,000,000
1894	64.21	31,300,000
1895	62.35	27,300,000
1896	60.21	32,000,000

"Now, if the St. Paul managers had not acquired this knowledge, and had worked their road in the last fiscal year at 65 per cent., the surplus for the common stock would have been just 4.40 per cent., with 4 per cent. paid as dividends. As they were able to do it for a little over 60, they showed 8 per cent. earned. Thus it appears how advantageous it would be if other corporations had St. Paul managers."

We have not undertaken to analze these figures, or the cost of operating the lines whose expenses are unfavorably compared with those of the St. Paul road, knowing, as we do, how misleading such a basis of comparison may be. Thus at 60.21 per cent. of gross earnings of $32,000,000 reported for the St. Paul road for 1896, the expenses would have been $19,267,200. Now suppose the rates for carrying freight and passengers during that period had been increased 10 per cent., the expenses remaining the same, their percentage would then have been only 54.4 per cent. of the earnings. On the other hand, if the rates had been reduced 10 per cent., the expenses remaining the same, then the latter would have been 66.9 per cent. of the earnings. Doubtless under the former state of affairs the wise men who write financial articles for the papers would have commended the managers and in the latter condemned them, while, as a matter of fact, the management would have been just as good in the one case as in the other, and in fact the economy would have been exactly the same in both. The difference of cost in running a passenger train is almost or quite inappreciable whether the trains are filled or not. Cost of superintendence, office expenses, salaries, interest, etc., remain very nearly the same whether the volume of traffic is large or small, but the relation or the percentage of the expenses to the earnings will diminish as the latter increase and vice versa.

For these reasons not much importance is assigned to what may be called the quantitative comparison of expenses of earnings, but it is true of railroads, as Thackeray jocularly expressed it of personal receipts and disbursements—income £2 9d.; outgo £2 10d.; result—misery; income £2 10d.; outgo £2 9d.; result—happiness. Of railroad companies it might be said—income $3,000,000; expenses $2,900,000: result—a dividend; income $2,900,000; expenses $3,000,000; result—a Receiver.

In the article in the *New York Times* which has been quoted it was said that the late Mr. Newell, President of the Lake Shore Railroad, had spent his life in improving that line, by straightening its curves, reducing its grades, improving its terminal facilities so as to make it more efficient as a dividend-earning enterprise. Mr. Newell was by profession and training a civil engineer and had an intimate knowledge of all the requirements which are essential in a great line of road to carry freight and passengers economically. He used this knowledge to the best advantage, but Mr. Newell was not a mechanical engineer and could not see as far through the furnace door of a locomotive as he could through an engineer's transit. All the indications seem to show that a mechanical engineer with the breadth of mind, knowledge, ability and level-headedness that Mr. Newell had could accomplish as much in the improvement of the efficiency of the rolling stock of a great railroad as he did in perfecting the line of the great road of which he was President.

This subject is again too big for the space we can now give to it, and so must be taken up again.

We heartily indorse the work which the *Railway Age* and other technical papers are carrying on for sound money in the present disturbed condition of business. It is worthy of the approbation of all who are interested in the cause of good government for *all* the people and opposed to measures that could only benefit the few at the expense of disaster and ruin to the many.

NOTES.

Mr. Shadrach A. Mustain, of Rincon, N. Mex., has patented a globular car. It consists of two globes for "transporting matter" attached to a suitable frame and having axles running in journal boxes. Each globe has two cylindrical surfaces, which form treads that run on the rails. The globes are hollow and the lading is carried inside of them. These would make excellent "rattlers" for cleaning castings, scrap iron, etc.

A test of the relative cost of coal and coke fuel was recently conducted for the directors of the gas and water works of Colmar, Germany. The tests were conducted on the boilers of the pumping plant of the town. The caloric values of the coke and coal were in the ratio of 1 to 0.89. The results showed that the cost of coke fuel was .92 times that of the coal required to generate the same amount of steam, or a saving of about eight per cent. in favor of the coke. The cost of the coal and coke per ton is not stated.

In the annual report of the New York, New Haven & Hartford Railroad for the year ending June 30, 1896, a reference is made to the company's experiment with the use of electricity as a motive power, and the statement is made that the result has been most gratifying and that it is now probable that a third rail may be laid at several points on the company's lines, after which short lines to centers of business and population would naturally follow. The company paid four dividends of 2 per cent. each last year, amounting to $3,608,542.

The use of a pneumatic arrangement for whitewashing and painting is gradually spreading. It has reached England and is received with favor there. It is in this country used on several large systems to paint freight cars, sheds and buildings along the line. Painting of ships is another of the operations in which it ought to work well, and it has, we believe, been already employed in this manner. The arguments at first raised against the process, the chief one of which was that the paint would not stick, seem to have been swept aside.

Mr. L. L. Buck, Chief Engineer of the new East River bridge estimates that with no unexpected delays and with the needed money forthcoming, the bridge can be completed by Jan. 1, 1900, at an expenditure of $7,510,000 on new contracts. Of this sum $1,360,000 is required for tower foundations, $1,640,000 for anchorages, $372,000 for the steel towers and $248,000 for their erection, $750,000 for the cables and their erection, $1,610,000 for the suspended superstructure and its erection, $1,300,000 on approaches, and $230,000 on flooring, painting, etc.

In a paper read before the Institute of Naval Architects, Col. N. Soliani, Director of Naval Construction in the Royal Italian Navy, recommended the adoption of compound marine boilers; that is, he proposes "compounding cylindrical boilers with water-tubes in such a way as to make them partake, to a certain extent, of the good features of the water-tube boilers, without detracting much from their own valuable characteristics." "Such a result," he says, may, in his opinion, "be achieved simply by doing away altogether with the water-spaces around the ordinary combustion chambers and substituting for them water-tubes, some of which could be properly arranged as a protecting screen in front of the tubes and tube-plates."

Three robbers tried to hold up the overland train on the Southern Pacific one night last month at a point between San Francisco and Sacramento. The engineer and fireman were covered by revolvers in the hands of two men, who crawled over the tender. The train was stopped by their orders and one of the would-be robbers left the cab to join an accomplice and aid in cutting out the express car, taking the fireman with him. The third robber guarded Engineer E. F. Ingles, but his attention was fixed on something else for a moment and the engineer promptly availed himself of his opportunity and shot him dead. The other two escaped. The fireman managed to elude them and got into the first coach as the train started again.

In a paper recently read before the Société Technique by Mr. Ravel, the author stated that acetylene kindles at about 900 degrees Fahr., while other inflammable gases fire at about 1,100 degrees Fahr. He said the temperature produced by the explosion of acetylene is over 7,200 degrees Fahr., while that of the oxy-hydrogen blowpipe is not more than about 5,400 degrees Fahr. This high temperature, together with the small amount of water vapor produced, makes the explosion of acetylene a very violent one. The flash produced is a blinding one, and it is very dangerous to bring a flame near a leakage of acetylene. Then the ease of lighting and the force of explosion promised to render acetylene very useful in gas engines. Tests were therefore made. The engine at first made a series of loud, sharp explosions, which threw the indicator lever out of gear. The lubrication had to be doubled, and the degree of cooling had a great deal more influence on the efficiency than when coal gas was used. The indicated work falls off with the proportion of acetylene. As the acetylene is increased the initial pressure rises, but the fall of pressure is immediate and the expansion is not kept up. As the acetylene approaches five per cent., the explosions become destructive, and there seems to be internal vibrations in the mixtures in the cylinder. Diminishing the compression, these vibrations are less and the work done is greater. The work done is then about 2.1 times as great as can be obtained from an equal volume of coal gas. Acetylene cannot be advantageously used in motors as at present constructed, for either it has to be too much diluted or else the explosion is too sharp.—*The Practical Engineer.*

An exchange says that at a recent congress of German engineers, at Cologne, Mr. Mansel presented a paper showing by that the use of petroleum water can be pumped in places where steam or hydraulic motors cannot be employed and gasworks do not exist. Gas moters are also adapted to the working methods of a gas plant, as the power can be utilized during the day time, when there is little or no demand for the gas as an illuminant. Germany was the first country to adopt gas as a motive power in pumping water. Gas motors, for this purpose, were installed at Duereu and Quedlinburg in 1884, at Coblenz and Rolhweil in 1886, at Fuerth and Peine in 1887, and at Münster and Carlsruhe in 1888. In some of these plants the gas motors are used with steam engines to supply any emergency demand. The last two plants in the following table show a material improvement in the utilization of gas. The motors used at Münster have an efficiency of 912,950 foot pounds per pound of fuel used. As an average there was used at this plant, in 10 hours, 170 pounds of coke and 400 pounds of anthracite coal for producing gas. A steam engine would have consumed three times this amount of fuel for the same work. At Rothenburg, where the motors are run with gasoline, the efficiency is 1,603,750 foot pounds per pound of gasoline. At Hohenstein, petroleum motors give an efficiency of 1,724,000 foot pounds per pound of petroleum. The following table shows the results obtained by gas motors in different waterworks, these works being arranged according to date of erection:

Towns.	Number of motors.	Horse power.	Foot-pound produced per cubic foot of gas used.
Duereu	2	40	46,565
Quedinburg	2	15	49,258
Coblenz	3	40	51,071
Fuerth	2	40	51 071
Carlsruhe	2	50	53,017
Kettwig	1	15	47,313
Einbeck	2	10	48,234
Bingen	2	12	52,228
Goettingen	1	10	52,676
Meissen	2	50	70,460
Constanz	1	10	71,276

Superheating has for its sole purpose and result in the steam engine to-day the extinction or reduction of the internal thermal wastes of the engine, consequent upon the phenomenon known as initial or "cylinder condensation." Here it is extraordinarily effective, and a small quantity of heat expended in superheating the entering steam effects a comparatively large reduction in the expenditure of steam in the engine, each thermal unit thus employed saving several thermal units otherwise wasted. The process is one, mainly at least, of prevention rather than of cure of that fault, and prevention is, as usual here, found to be vastly more effective than attempted cure.

Superheating is superior to any other known means of reduction of internal waste. Jacketing ordinarily suppresses but a fraction of that waste, and the multiple-cylinder engine has also its limitations, while superheating may not only extinguish it, but may also check wastes due to the resistance to flow of the denser wet steam through steam and exhaust ports, and may sensibly improve the vacuum attainable in the condenser, with corresponding reduction of back pressure, of the quantity of condensing water demanded, and of the load on the air pump. Superheating even a few degrees improves considerably the performance of the engine, and in the average case superheating 100 degrees Fahr. will entirely extinguish that waste. The hitherto unconquered obstructions to the use of superheated steam in the engine have been those resulting from destruction of packing and decomposition of lubricants, with consequent friction and "cutting" of the rubbing surfaces. The introduction of metallic packings and the high-test lubricants has now enormously reduced the difficulties of application of superheating. No trouble need now be found at the engine with sufficient superheating, under usual conditions of operation, to annihilate cylinder condensation. It seems not at all improbable that even this limit may be ere long safely, and perhaps even largely, overpassed, with resulting improvement of thermodynamic efficiency.—*Dr. R. H. Thurston, before the Am. Soc. of Mech. Eng.*

In a paper before the American Society of Mechanical Engineer, describing a new steam calorimeter in which the water is separated from the steam by a sudden change in direction of flow which causes the water by its inertia to be forced through the meshes of a cup placed in its pathway, the water being collected and measured, while the weight of the dry steam is derived by its flow through an opening that has been calibrated, for different pressures. Prof. R. C. Carpenter gives the following conclusions as guides to calorimetry practice: First, the steam ordinarily discharged from a boiler of proper proportion and in good working condition carries an exceedingly small percentage of water. Second, a certain amount of water will be carried along by the steam in the form of vapor or small drops; that this amount varies somewhat with the velocity, but probably does not exceed two or three per cent. by weight, and furthermore, a fair sample of such steam is usually obtained by any of the ordinary methods in use. Thirds water is sometimes thrown from the boiler in large amounts, and in such a case it will usually remain distinct from the steam and will pass along the bottom of horizontal pipes in a stream of greater or less depth, and will flow if moving downward in a vertical pipe in irregular positions depending upon its velocity and various other considerations. Steam carrying water in this way when ascending in a vertical pipe will probably be irregularly charged, and samples drawn from time to time are likely to vary greatly. This condition can usually be considered an abnormal one and probably cannot be fairly sampled by any method. In case large amounts of water are thrown over, the quality of the steam cannot be even approximately obtained without the use of a steam separator for removing the excess of water. Fourth, steam, even in a very dry condition is likely to deposit a film of water on the inside of the pipe by condensation. This amount is rarely of sufficient importance to greatly affect the results, but if the calorimeter is so located as to draw this directly into the pipe it may show very wet steam when the contrary condition actually exists. The writer believes that samples for calorimetric determination should be drawn from a vertical pipe in which there is an ascending current of steam, and that the sample should be taken as uniformly as possible from all sections of the pipe, except that no steam should be drawn immediately adjacent the exterior portion of the pipe; and in such a case the results will indicate, if substantially uniform, in all cases not showing an excessive amount of moisture, *the average quality of the steam within reasonable limits of errors of observation.* Further, if the determinations obtained by the calorimeter in this position are irregular, or show large percentages of error, it may be reasonably doubted that the sample of steam obtained is accurate. Fifth, a steam separator is always desirable to remove excess of water from the main steam pipe, in which case determinations should be taken after the steam has passed the separator. The writer, however, believes from his own experience that the use of the separator will not be found essential in one case out of twenty, for the reason that the water is very rarely thrown into the steam in larger quantities than the steam itself will take up and retain in a uniformly distributed condition.

Personals.

Mr. G. W. Dickinson, General Manager of the Western lines of the Northern Pacific, has resigned.

General James Jourdan has been appointed temporary Receiver of the Kings County Elevated road.

Mr. C. O. Skidmore, Master Mechanic of the New York, Philadelphia & Norfolk Railroad, has resigned.

Mr. Charles W. McMeekin has been appointed Chief Engineer of the Iowa Central, with office at Marshalltown, Ia.

Mr. F. F. Graf has been appointed Receiver of the Ohio Southern Railroad in place of Mr. J. R. Megrue, resigned.

Mr. W. H. McDoel, General Manager of the Louisville, New Albany & Chicago, has been appointed Receiver of that road.

Mr. C. W. F. Felt has been appointed Chief Engineer on the Gulf, Colorado & Santa Fe Railroad with headquarters at Galveston.

Mr. R. P. C. Sanderson, Division Superintendent of Motive Power of the Norfolk & Western, has resigned, and that position has been abolished.

Mr. A. G. Wright has been appointed Division Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, with headquarters at Altoona, Wis.

Mr. J. H. McGill has been appointed Master Mechanic of the New Orleans and Northwestern and has charge of the locomotive and car departments and the water supply.

Mr. Henry Kistner has been appointed General Foreman of Motive Power and Car Department of the Monterey & Mexican Gulf Railroad, with headquarters at Monterey, Mex.

Mr. W. J. Miller has been appointed General Foreman of the Machinery Department of the Columbus, Sandusky & Hocking, at Columbus, O., to succeed Mr. P. T. Bancroft, resigned.

Mr. William Gibson, formerly Superintendent of the Cincinnati, Columbus and Sandusky divisions of the Big Four, has been appointed Assistant General Manager of the Baltimore & Ohio.

Mr. James Gaston has been appointed Master Car Builder of the Louisville, Evansville & St. Louis Railroad, with headquarters at Princeton, Ind. He takes the place of Mr. W. E. Looney, resigned.

Mr. W. H. Newman has accepted the position of Second Vice-President of the Great Northern and has resigned as Third Vice-President of the Chicago & Northwestern. His headquarters will be at St. Paul, Minn.

Mr. William Sinnott, formerly General Foreman of the Baltimore & Ohio shops at Philadelphia, has been appointed Division Master Mechanic of the Second and Third divisions, with headquarters at Cumberland, Md.

Mr. R. B. Burns, for years resident Engineer of the Atlantic & Pacific at Williams, Ariz., has been appointed Chief Engineer of that road, in charge of the maintenance of roadway and buildings, including service department.

Mr. J. G. Thomas, Assistant Superintendent of Motive Power and Equipment of the Central of New Jersey, with headquarters at Ashley, Pa., has been appointed Superintendent of Motive Power of the Lehigh & Susquehanna Division.

Mr. William H. Baldwin. Jr., has resigned the position of Second Vice-President of the Southern Railway to accept the Presidency of the Long Island Railroad, vice Mr. Austin Corbin, deceased. Mr. Baldwin will have his headquarters in New York.

Mr. W. G. Pearce, heretofore Assistant General Manager of the Northern Pacific, has been appointed Assistant General Superintendent of the reorganized road, with headquarters at Tacoma, Wash. Mr. Pearce will have jurisdiction over the lines west of Billings, Mont.

Mr. S. B. Hynes is General Manager of the Los Angeles Terminal Railway. Mr. William Wincup has resigned as Acting General Manager and Secretary, and Mr. F. K. Rule has been chosen Secretary. Mr. W. J. Cox has been appointed Assistant to the General Manager.

Mr. W. W. Finley, Second Vice-President of the Great Northern, has been elected Second Vice-President of the Southern, to succeed Mr. W. H. Baldwin, Jr. Mr. Finley was formerly Third Vice-President of the Southern, which position he resigned to return to the Great Northern, of which he had been previously General Traffic Manager.

Mr. W. H. Hudson, formerly Master Mechanic of the Southern Railway in Atlanta, has been appointed Master Mechanic at Salisbury, N. C. Mr. W. L. Tracy, formerly Master Mechanic at Birmingham, has been transferred to Atlanta, and Mr. W. A. Stone is transferred from Selma, Ala., to the position of Master Mechanic at Birmingham. Mr. Thos. M. Feeley takes charge at Selma.

Mr. E. H. McHenry, formerly Chief Engineer and lately one of the Receivers of the Northern Pacific, is now Chief Engineer of the reorganized road. Mr. W. L. Darling, who has been Chief Engineer since last April, has been appointed Division Engineer, with headquarters at St. Paul, Minn., in charge on lines east of Billings, Mont. C. S. Bihler is appointed Division Engineer, with headquarters at Tacoma, Wash., in charge on lines west of Billings, Mont.

J. F. Holloway.

Among a very large circle of friends and acquaintances the news of the death of the former President of the Society of Mechanical Engineers, which occured at his home at Cuyahoga Falls, O., on September 1, was received with profound sorrow. His cheerful disposition, his hopefulness, his companionable nature, endeared him to all who had the privilege of his acquaintence. He was 71 years of age at the time of his death, which occurred after a brief illness, and was due to Bright's disease.

His business career was commenced in the works of the Cuyahoga Steam Furnace Company, in Cleveland. After his apprenticeship in this establishment he secured a place as Superintendent of a manufacturing company in Southern Illinois. He remained there until 1861, when he returned to Cleveland as Superintendent of the works in which he began his career. He occupied that position until 1872, when he was elected President of the company, which office he filled until the company went out of business in 1887. While occupying that position, it is said by a writer in the *Marine Review*, "By his industry, ingenuity and engineering skill, he assisted more than any man in laying the foundation of what is now regarded as the greatest merchant marine on any inland sea."

After the property of the Cuyahoga Company was sold, Mr. Holloway became associated with the Worthington Steam Pump Company, of New York, and remained there until about a year ago, when he became Consulting Engineer of the Snow Pump Company, of Buffalo, N. Y., which position he occupied at the time of his death.

He was one of the charter members of the American Society of Mechanical Engineers, and was elected President in 1884. He was also a member of the American Institute of Mining Engineers and of the Engineers' Club, of New York, and while a resident of Cleveland was a member of the Cleveland Civil Engineers' Society, of which he was at one time President. He often contributed papers to these associations, and took part in their discussions. He had the faculty of making what he wrote and said interesting and easy of comprehension, which is not true of many of the contributors to engineering literature.

In the association of which he was a member he will be missed as long as those whose privilege it was to have his acquaintance will live. He always met them with a genial smile, and the sense of humor, which was one of his characteristics, attracted to him those into whose society he was thrown. Men who knew him best appreciated most the serious side of his character. With a long and varied experience in engineering, he had developed what may be called mechanical sagacity and a very sound judgment, which is of such great value in all engineering enterprises. In the words of the writer from whom we have already quoted, "One never failed to derive great benefit from his advice and pleasing suggestions, and yet the man of this disposition had the ability and capacity to manage successfully large engineering establishments, employing hundreds of men, whose confidence and esteem he enjoyed. He was held in the highest regard by his employees, and up to the time of his death had lost, among them still living, none of the good feeling that was due him from early years."

A wife, one son and one daughter survive him.

Equipment Notes.

The Baltimore & Ohio Railroad has received a large number of the 75 engines ordered several months ago.

The Northern Pacific is reported to have issued specifications for compound locomotives of special design.

The Chicago & Alton Railroad is building at its Bloomington shops 100 coal cars of 60,000 pounds capacity.

The Chicago, Rock Island & Pacific has given an order for 100 box cars to the Michigan-Peninsular Car Company.

The Baltimore & Ohio recently ordered a small electric locomotive for use in switching at the Baltimore terminals.

The Richmond Locomotive Works has orders for three 6-wheel connected engines for the Georgia & Alabama Railroad.

The Wabash is building two mail cars at its Toledo shops. The cars are 60 feet long and are equipped with Pintsch gas.

The Rogers Locomotive Works has been awarded a contract for three ten-wheel locomotives for the Keokuk & Western Railroad.

The Midland Terminal, of Colorado, has ordered two new engines and four new coaches for service between Cripple Creek and Gillett.

It is reported that the order for 100 refrigerator cars for Swift & Company, which was held up some time ago, will be let in the near futnre.

It is stated that the Pittsburgh Locomotive Works has orders for three 6-wheel connected engines from the China and Japan Trading Company.

It is reported that the Baldwin Locomotive Works has been awarded the contract for locomotives for the Tientsin & Pekin Railway, which is a part of the Imperial Railway of China.

At the car shops of the Northern Pacific Railroad, South Tacoma, Wash., 120 new flat cars, of 70,000 pounds capacity, will be built in the next two months. The shops are also increasing the capacity of several hundred cars from 40,000 pounds to 50,000 pounds.

The Baltimore & Ohio Railroad put their new machine shops in Cumberland, Md., into operation last month. The shops cost $340,000, including what is said to be the largest round house on the system.

The first shipment of motor cars for the New York and Brooklyn Bridge was received last month from the Pullman Car Company. The new cars are fitted with heavy motors, also a cable grip. The cars were run on their own trucks from Chicago. Each train over the bridge will have one of these motor cars attached for switching at the terminals.

The Fire-Retarding Qualities of Wired-Glass.

In a paper on the fire-retarding qualities of wired-glass, by C. A. Hexamer, C. E., in the Journal of the Franklin Institute for August, there is given the result of a test of wired-glass made at the request of the Mississippi Glass Company, and reported to the Philadelphia Fire Underwriters' Association. Briefly told the test is as follows: A brick test-house, about 3 by 4 feet, inside measurement, and nine feet high, was constructed in the yard of the Pennsylvania Iron Works. In one side of this structure a wired-glass window was fastened in a wooden frame, covered with lock-jointed tin. In another side, a Philadelphia standard fire-door was hung. The upper part of this door had a pane of wired-glass, 18 by 24 inches, set into a wooden metal-covered frame. The entire roof of the test-house was replaced by a skylight, the sash being constructed of wood, metal-covered; one side of this skylight being provided with three lights of ¼-inch ordinary rough glass, the other side with three lights of wired-glass. The wired-glass used was ¼ inch thick, and was manufactured by the Mississippi Glass Company, of St. Louis. Iron grate bars were placed in the bottom of the test-house, and openings were left in the wall near the ground for free draught. The test house was filled for two-thirds of its height with wood treated with a liberal allowance of coal oil and resin. In a few minutes after the fire was started the ordinary rough glass in the skylight cracked and pieces began to fall into the fire. The wired-glass in the fire-door soon became red hot, also the three plates of wired-glass in skylight, but they retained their positions throughout the test. At the end of 30 minutes, water was thrown on the fire and also on the hot glass. After the fire was extinguished, the three plates of glass in the skylight were found to be cracked into countless pieces, but still adhering together, forming one sheet. The window light, which, as the result showed, was not properly secured to the frame, was found to be in same condition as skylight glass, except that a large crack had developed. The plate of glass in the standard fire-door was cracked, the same as the skylight; but having been well secured into the door frame, it did not give way. The action of the fire on the wooden metal-covered skylight and window frame showed conclusively that this class of construction is far superior to iron framing, no warping or giving way of any portion of the frames being noticed. The fire door in direct contact with the fire showed but little buckling on the inner side, and no signs of giving way. On removing the tin covering, it was found, however, that the inner layer of 1-inch boards was completely charred through, but that the second layer was only slightly damaged.

The conclusions to be drawn from the test appear to be as follows:

(1) Wired-glass can safely be used in skylights, and in such situations will withstand a severe fire and will not give way when water is thrown on it. A wooden framing for skylight, covered with tin, all seams lock-jointed and concealed-nailed, is superior in fire-resisting quality to iron framing.

(2) Wired-glass in wooden sash, covered with tin, all seams lock-jointed and concealed-nailed, can safely be used for windows toward an external exposure.

(3) Wired-glass can safely be used in fire-doors to elevator shafts and stairway towers, where it is necessary to light said shafts.

(4) In office buildings, hotels, etc., where it is undesirable to have elevator shafts entirely enclosed and dark, wired-glass permanently built into a brick or terra-cotta shaft, or arranged in a wood metal-covered frame, can safely be used.

(5) Wired-glass plates, securely fastened in standard fire-shutters, can safely be used toward an external exposure. In this case, the fact that a possible fire in a building, all windows of which are protected by fire-shutters, can much more readily be detected from the outside through the wired-glass, is of importance.

Why an Electric Motor Revolves.*

The action of the current in producing rotation in an electric motor is quite simple.

The fundamental fact is the relation between an electric current and a magnet. If a piece of iron be surrounded by a coil through which current is passed, it becomes a magnet. It will attract iron, and the space surrounding it becomes magnetic. Iron filings will arrange themselves in the direction shown by the dotted lines in Fig. 1. One end of a magnet is a north pole and the other a south pole.

If a wire, such as *CD*, be moved past either pole of the magnet, there will be a tendency for current to flow in the wire either from *C* to *D* or from *D* to *C*, according to the character of the pole past which it is moved and to the direction of the movement. If the ends of the wire *CD* are joined by a conductor, so that there is a complete circuit, a current of electricity will flow through the circuit.

The reason why there is a tendency for an electric current to flow in the wire *CD* when it is moved in the vicinity of a magnet is not known. There are several theories, all more or less involved and depending upon pure assumptions as to the nature of an electric current. For all practical purposes it matters not what the reason is; the fact that current flows when there is an electric pressure in a closed circuit is the important thing, and it serves all useful purposes to know that current does flow, and that its direction and amount are always the same under similar circumstances.

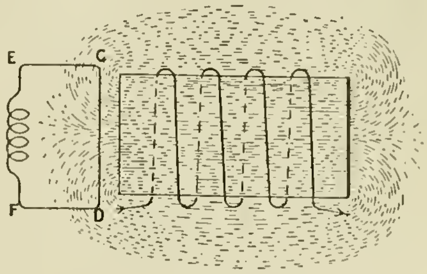


Fig. 1.

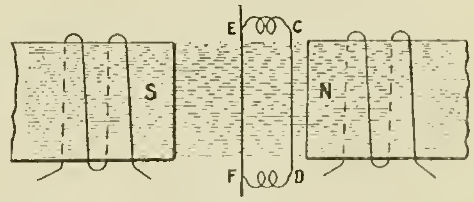


Fig. 2.

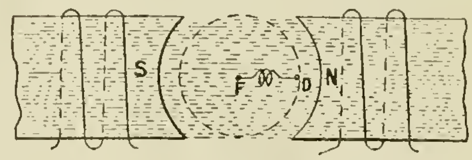


Fig. 3.

The intensity of the electric pressure, or electro-motive force, depends upon the velocity of revolution of the wires and upon the strength of the magnets, and the quantity of current depends upon the electro-motive force and upon the amount of the resistance in the circuit. Other things being equal, the current through a long small wire, or greater resistance, will be less than through a short thick one, or a less resistance.

Two electro-magnets are shown in Fig. 2, in which the north pole of one magnet is near the south pole of the other, and the magnetic field between the two lies in approximately straight lines between the two magnets, as indicated by the dotted lines. If the wire *CD* be moved across this field and its ends be joined, as by the circuit *CEFD*, a current will flow in this circuit. The wire *CD* may be made to revolve around the wire *EF*, passing in front of one pole and then in front of the other pole, as in Fig. 3. The current in the circuit will pass in one direction when the wire is passing one pole, and in the other direction when it is passing the other

* From a pamphlet or catalogue of electric locomotives, issued by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Company, and written by Mr. D. L. Barnes.

pole. The connection between this elementary arrangement and the dynamo is easily recognized. In the dynamo a magnetic field is produced by electro-magnets called " field poles," and a considerable number of wires similar to the wire *CD* are placed upon an armature so that they revolve in front of the poles. Each individual wire produces current first in one direction and then in another direction, as explained above ; but if there be many wires, there will always be the same number in front of the positive pole and the same number in front of the negative pole, so that the total or resultant action is practically uniform and may be made to produce a continuous current. Such a machine is the common dynamo or motor.

A dynamo transforms mechanical into electrical energy, and a motor transforms electrical into mechanical energy. The two operations are reversible and may be effected in the same machine; a dynamo may be used as a motor or a motor may become a dynamo. A machine is a motor when it is driven by a current of electricity, and it is a dynamo when it is driven by mechanical power and produces an electric current. A simple form of electric machine is shown in Fig. 4, which is the general form of the electric motor. In this there are two projections of steel, *H* and *G*, which are made electro-magnets by the current going through the wires wound around them from any source of electricity, such as a battery at *I* and *J*. These magnets have poles facing toward a drum, *K*, revolving on a shaft. The poles *G* and *H* are called the "salient" poles; the other two the "consequent" poles. The magnetic flow or field is shown by the dotted lines. On the periphery of the drum are arranged wires in the slots shown. As this drum is revolved, there will be a tendency for electricity to flow in the wires. In order to get a current of electricity from these wires it is necessary to make a complete circuit. As each of the wires in the slots passes

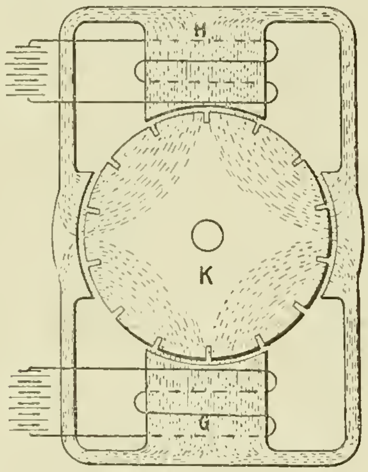


Fig. 4.

in front of a pole, a pressure or electro-motive force will be generated, and its direction will depend upon whether the pole is a north or a south pole.

The pressure or electro-motive force generated in the wires moving in front of the positive or north field poles will be in one direction, while those in front of the negative or south poles will be in the opposite direction. Therefore, if two such wires be connected together at one end of the armature, the free terminals of the wire at the other end of the armature will have the sum of the electro-motive forces generated in the two wires. The wires so connected can be considered as a turn of a single wire, instead of two separate wires, and this turn may be connected in series with other turns, so that the resulting electro motive force is the sum of that in all the turns and all the wires so connected. It is customary to connect the coils of an armature so that the electro-motive force given is that obtained from half the coils in series. The other half of the coils is connected in parallel with the first half, so that the currents flowing in the two halves will unite to give a current in the external circuit equal to twice the current in the two armature circuits or paths.

It is evident that, as the armature revolves, wires which were in front of the positive pole will pass in front of the negative pole, and that in order to maintain the electro-motive force it will be necessary to change the connections from the armature winding to the external circuit in such a way that all the wires between the two points of connection will have their electro-motive forces in the proper direction. The connection to the armature must therefore be made not a definite point in the armature itself, but at a definite point with reference to the field magnets, so that all the wires between two points or contacts shall always sustain the same relation to the field magnets.

For this purpose a device known as a "commutator" is provided. The commutator is made of a number of segments, as shown at *A*, in Fig. 5, which are connected to the armature winding. On the commutator are sliding contacts, or brushes, which bear on the segments and are joined to an external circuit, making a continuous path through which current may flow. As the commutator revolves the different segments come under the brushes, so that the relative position of the armature wires between the brushes is dependent on the position of the brushes. The armature wires which connect the brushes are those sustaining the desired definite position to the field magnets, so that the currents from the armature at all times flow properly into the external circuit, although indi-

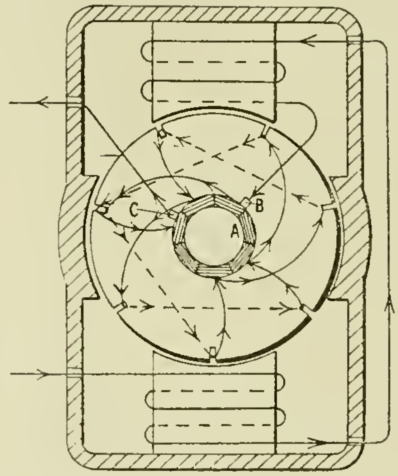


Fig. 5.

vidual armature wires carry currents first in one direction and then in the other direction, depending on the character of the pole in front of which they may be moving.

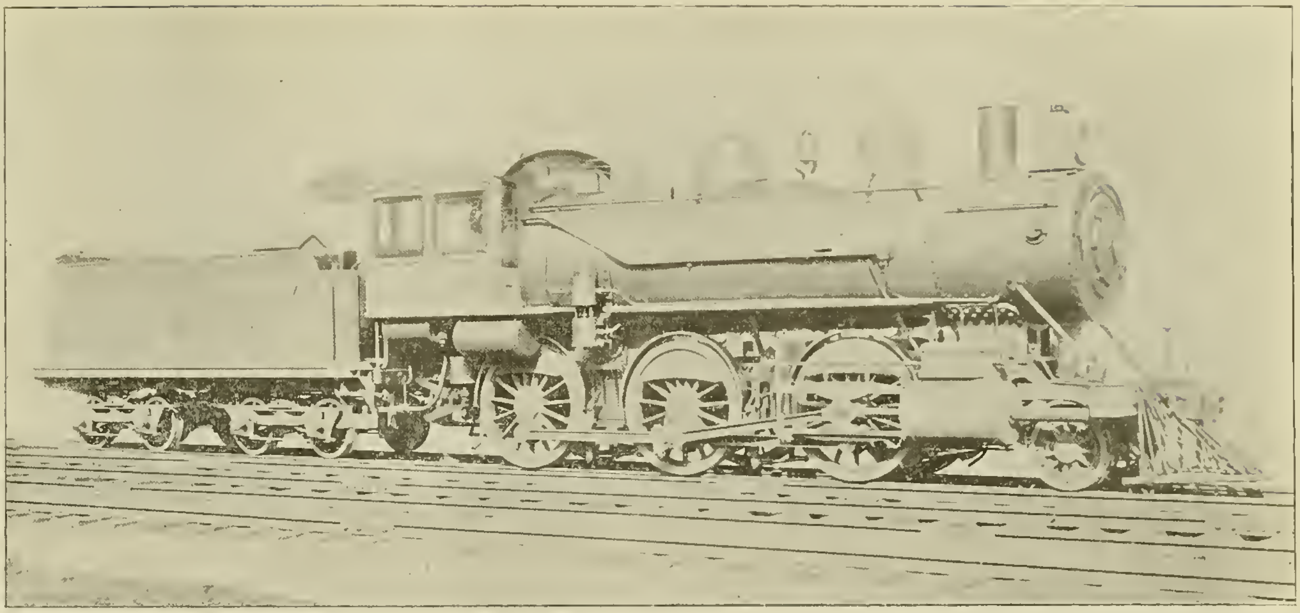
On two-pole machines there are two brush-holders, each containing one or more brushes. On the four-pole machine there may be either two or four brush-holdors, and on a six-pole machine, either two, four or six brush-holders.

A single path of the current through the commutator and armature winding is shown by the arrows on Fig. 5. The brushes *B* and *C* are placed on the top side of the commutator to make them more accessible, and this gives a peculiar but simple armature winding.

For the sake of simplicity, the batteries *I* and *J* of Fig. 4 are not used on common forms of generators or motors, but the current that flows from the armature through the commutator is made to flow through the electro-magnets either in whole or in part. If all of the armature current flows around the electro-magnets or fields of the machine, it is a "series" machine; if only a part of the current is used in this way, it is a "shunt" machine, that is, some of the current is "shunted" through the fields. Sometimes both the shunt and series windings are used, and in that case the machine is called a "compound wound" machine. Such a machine has a large wire through which the main current passes, and a fine wire through which the shunted current flows. Fig. 5 shows how the commutator and the fields are connected, and how the current flows from the wires in the armature through the commutator in a series machine.

If the current delivered by a dynamo does not flow in the desired direction, it can be reversed by shifting the wires in the binding posts or by throwing a switch. If the motor does not revolve in the desired direction, it can be made to do so by reversing the connections to the armature or field-coils; so that, without knowing which way a current of electricity is to be generated, any practical man can make a motor revolve in a proper direction by simply changing the connections.

It is natural that a machine which gives out electric energy when driven by an external power will, when electric energy is delivered to it, reverse its action and give out mechanical power and do work. This is not a logical reason why a motor revolves under the influence of an electric current, but it is a natural inference which assists in comprehending the fact.



Mogul Freight Locomotive for the New York, New Haven & Hartford R. R.—Built by Schnectady Locomotive Works.

Perhaps the simplest way to explain the cause of the movement of an electric motor, when supplied with a current, is to compare the action to the well-known attraction of unlike poles or magnets and the repulsion of like poles. In any motor the current through the field causes a north or south pole to be maintained, and the current through the armature and brushes causes an opposite polarity. These constantly maintained unlike poles attract each other and pull the armature around on its axis.

It has been explained that if a motor be driven by a belt an electro-motive force is produced and the machine acts as a dynamo. It is also a fact that an electro-motive force is produced whether the power for driving the machine is obtained from a belt or from the electric current—that is, whether the machine be driven as a dynamo or as a motor. In a dynamo, however, the current flows out in the direction in which the electro motive force is acting. In a motor the electro-motive force produced has a direction opposed to the the direction of the flow of current. This may be illustrated by the following experiment:

Two similar machines are driven independently at 600 revolutions and give an electro-motive force of 100 volts. Similar terminals of the two machines are connected together. No current flows between the machines because the two pressures are the same and are opposed in direction. If now the belt be thrown off from one machine its speed will begin to fall. This will lower its electro-motive force below that of the other machine or dynamo, but will not change the direction of the force. There will now be a difference of pressure in favor of the machine which is driven, and it will now send a current through the other machine and run it as a motor. The speed of the motor will continue to fall until the difference in pressure or electro-motive force between the two machines is just sufficient to cause the flow of enough current to keep the motor running against whatever frictional resistance and other resistance there may be. The electro-motive force generated in the motor, which is against or counter to that of the current in the circuit, is called the "counter electro-motive force."

In order to determine how fast a motor will run without doing work under any given pressure, it is not necessary to know anything about the dynamo that furnishes the pressure. The pressure alone is sufficient to determine the speed of the motor. For instance, if a motor will give a pressure of 500 volts when running free at 100 revolutions, it will always run at about 100 revolutions when not doing work on any electric circuit where the pressure is 500 volts.

This description of a motor or dynamo carries with it all of the fundamental theory of electrical generators and motors that it is necessary for a mechanic to know in order to take reasonably intelligent care of electric locomotives. Further useful knowledge must be attained by studying the different types of electric motors and dynamos. These other types all have the same fundamental theory, even when the construction is quite different.

Mogul Freight Locomotive—New York, New Haven & Hartford R. R.

We show in the accompanying engraving one of ten mogul freight locomotives which the Schenectady Locomotive Works recently built for the New York, New Haven & Hartford R. R., from specifications prepared by Mr. John Henney, Superintendent of Motive Power. They have cylinders 20 inches by 28 inches, and driving wheels 63 inches in diameter. The driving wheel centers are of cast steel, as are also the pistons, foot plate and driving boxes. Pressed steel is used for the boiler front and door, cylinder head casings, dome ring, dome cap and dome casing. The flanging of boiler plates is done on an hydraulic flanging press. The arrangement of cab is the same as on the 20 inch by 24-inch passenger engines recently sent to the same company, and gives very comfortable quarters for the engineer and fireman.

From the data given below it will be seen that the engine has great power and weight—124,450 lbs. on three pairs of drivers being about 41,500 lbs. per pair.

Cylinders	20 inches by 28 inches
Driving wheels	63 inches
Driving wheel base	15 feet 2 inches
Total wheel base of engine	23 feet 3 inches
Weight on drivers	124,400 pounds
Total weight of engine in working order	144,200 pounds
Boiler, diameter	62⅜ inches
Firebox	108⅛ by 40¼ inches
Tubes, number of	312
" size of	2 inches O. D. by 12 feet
Heating surface, tubes	1,946.72 square feet
" " firebox	164.38 square feet
" " total	2,111.10 square feet
Boiler pressure	190 pounds
Grate area	30.22 square feet

The tank has a capacity of 4,500 gallons and the tender will carry 8½ tons of coal. The boilers are of carbon steel, and among the fittings might be mentioned Metropolitan injectors, consolidated safety valves, magnesia sectional boiler covering, Westinghouse brakes, Paige steel-tired truck-wheels, Richardson balanced valves and Jerome metallic packing.

Western Railway Club.

The September meeting of the Western Railway Club was held on the 15th, and was followed in the evening by the annual banquet. At the meeting the paper of Mr. D. L. Barnes, on the power and efficiency of electric locomotives, was discussed, also the paper of Prof. Goss on the performances of the Purdue locomotive, both of which papers were read at the May meeting. A committee was appointed to suggest at the next meeting remedies for certain difficulties that had come up under the new rules of interchange. Mr. E. M. Herr led the discussion on "Difficulties with the Use of Metal Underframes for Tenders and Cars." A paper on the "Apprentice Boy" was read by Mr. J. N. Barr.

Switching Engine Burning Crude Petroleum.—Built by Brooks Locomotive Works

At the banquet several excellent addresses were made. President Waitt, speaking on "Our Club," said, in part:

We cannot as a club look back on long years of work, the organization being to-night but 12 years and five months old. We cannot boast the largest membership, for our newly born sister club at St. Louis has for the time being outnumbered us. But the Western Railway Club can with pride look back over 12 years' work and point to some of the most valuable papers, from both a technical and practical standpoint, that have ever emanated from any similar organization. The Western Railway Club has been peculiarly fortunate in its membership. It is with great satisfaction that we are able to point to the fact thas we have among our active members a large number of men fortified by a thorough technical training which has been supplemented by years of practical work, enabling them to bring to the deliberations of our club the sound reasoning and good judgment for which our work has for many years been noted. . . As we look with pride on the past we should not stop satisfied.

Colonel H. G. Prout, of the *Railroad Gazette*, responding to "The Press," alluded to the railroad profession and then questioned if he was exactly right in using the term "profession." He believed, however, that the professional spirit was on the increase. He said, in part.

I like to think that the professional spirit is growing fast among railroad officers. Whether or not railroading is a profession; whether or not it ever can be a profession, is a small matter and the vital thing is that railroad officers should have the professional spirit. We must look to this spirit to save the railroads from the ignorant and corrupt subordinate. We must look to it to save the the railroads from the brigands in high places seeking only to make their own fortunes. Perhaps we must look to it to save the railroads from confiscation by Socialists and Populists, and, in fact, by honest voters who would come to be classed with either. How the professional spirit will do all this I need not point out. It will administer the properties for the interest of their owners and not for the profit of salaried officers. But, in the long run the interest of the owners is the interest of the public, and thus we find the probable solution of much that is most troublesome in what is called the railroad problem.

Other speakers were President Lemont, of Purdue University. Mr. J. H. P. Hughart, Second Vice-President, and General Manager of the Grand Rapids & Indiana Railroad; Mr. M. C. Markham, Assistant Traffic Manager of the Illinois Central; Mr. F. W. Morse, of the Grand Trunk; Mr. Geo. H. Heafford, Mr. H. C. Buhoup and Mr, E. B. Leigh. A straw vote for the presidential candidates resulted thus: McKinley, 89; Palmer, 4; Bryan, 0.

Locomotive for Burning Petroleum Fuel.—Built by the Brooks' Locomotive Works.

In the accompanying illustration we show an interesting engine recently built by the Brooks' Locomotive Works, Dunkirk, New York. It is a six-wheeled switching locomotive for the Congress Gold Company, of Congress, Ariz., and is equipped for the use of crude petroleum as fuel. The details of the oil burning specialties are not fully covered by patents and therefore we are not at liberty to publish them at present, but we expect to place them before our readers in the near future. The engine has cylinders 17 inches by 24 inches, driving wheels 51 inches in diameter, a boiler 56 inches in diameter, a firebox 78 inches by 32 inches, a driving wheel base of 11 feet, and a total wheel base of 46 feet 6 inches, including tender. The total weight of the engine alone in working order is 112,000 pounds. The boiler pressure is 180 pounds. The tank capacity is 3,600 gallons of water and the oil tank will hold about five tons of petroleum. The engine is fitted with Jerome metallic packing, Nathan injectors and cylinder lubricator, McKee-Fulla steel tired wheels under tender, National brake beams, Cooke bell ringers, Westinghouse brake and train signal, also the Le Chatelier water brake, Janney couplers, Tilden wrecking frogs and the Nathan fire extinguisher.

Electric and Compressed-Air Locomotives for the Manhattan Elevated.

The electric locomotive which the Manhattan Elevated Railway will try upon the Thirty-fourth street branch of its lines is now complete. It has the same arrangement of running gear as the present steam locomotives on the road, there being two pairs of drivers and a four-wheeled truck.

There is a motor on each driving axle. The motors will take current from a third rail, but the locomotive carries a large number of storage batteries which will be charged from the third rail when the current required for the motor is below a certain amount and which will automatically furnish current to the motor, in addition to what the latter receives from the third rail when the demands on the motor are heavy. In this way the batteries take care of the "peak" of the loads.

The company is also about to try a compressed-air motor of the Hardie type. This is now building at Rome, N. Y. We understand that both the compressed-air and electric locomotives will weigh slightly more than the present steam locomotives.

The British Admiralty have ordered the stern torpedo tubes to be taken out of all ships of the *Royal Sovereign* class, and these vessels will now carry only the submerged tubes. There are two very substantial reasons for this course. Experiments have been made which have demonstrated the possibility of hitting the whiskers of a torpedo by means of quick-firing guns while the weapon is in the tube and thus hoisting the engineer with his own petard. Then (says the *Naval and Military Record*) it has been found on the China station that where the stern tube is reasonably near the water-line the seas in rough weather fill the tube, and, if the torpedo is there, collapse the balance chamber. The trials of the *Eclipse* were especially directed to elucidate this point, but though no accident occurred in that cruiser, owing to her tube being well out of the water, an immunity from accident is not guaranteed to ships less favorably constructed. Hence the necessity that has arisen for removing the tubes.—*Exchange*

The New Battle-Ships.

The bids for three new battle-ships authorized by Congress at its last session were opened in Washington on Sept. 14. The bids were as follows:

John H. Dialogue & Sons, Camden, N. J., one battle-ship for $2,661,000.

Bath Iron Works, Bath, Me., one battle-ship for $2,680,000.

Newport News Shipbuilding and Dry Dock Company, Newport News, Va., one battle-ship for $2,595,000.

Union Iron Works of San Francisco, one battle-ship for $2,674,950.

William Cramps & Sons' Ship and Engine Company, Philadelphia, one battle-ship for $2,650,000; two battle-ships for $2,650,000 each.

As a difference of 4 per cent. in favor of Pacific coast builders has always been allowed on account of the cost of transporting materials across the continent and to offset the voyage of the Atlantic-built ships to the Pacific for duty on that ocean, this must be deducted for the purpose of comparison, thus bringing the San Francisco bid down to $2,598,982, or within $3,952 of the lowest bid, and considerably under that of the Cramps.

The result of the bidding is that the Newport News Company, the Union Iron Works and Wm. Cramps & Sons Company will each build one ship.

These battle-ships are to be the most powerful yet constructed for our navy. In size, displacement and general characteristics the new vessels will not be much different from the *Indiana*. The total length on the water line will be 368 feet, or only a few feet longer than the *Indiana* class, while their extreme beam will be 72 feet 2½ inches, which makes them the widest battle-ships in the navy. Their freeboard, 19½ feet, will also be a little above that of battle-ships of their class, and as the guns will be several feet above the decks, their fire is expected to be as efficient as the batteries of the *Kearsarge* and *Kentucky* type, with their great superposed turrets mounting 8-inch guns above the 13-inch rifles. The freeboard aft is 6 feet below its extreme height forward. The normal displacement is given as 11,525 tons, but it will approximate 12,000 tons when the ships are in actual service and ready for fighting. The displacement is about the same as that of the *Kearsarge* type.

To propel these vessels 10,000 horse power will be required to give them an estimated speed of 16 knots in a seaway. In this respect the vessels are supposed to be one knot better than the *Indiana* type, whose plans only called for 15 knots an hour on a four hours' run. The normal coal supply will be 300 tons, and the maximum bunker capacity 1,200, the latter supply enabling the big ships to have a wide radius of action at a 10-knot speed.

In the batteries of these ships the ordnance officers have endeavored to present the largest quantity of heavy ordnance carried by any ships of their class afloat. The arrangement of the guns, especially those of the secondary battery, is the best for raking fire yet designed, and, while there has been a departure in the assignment of ordnance from that followed in the *Indiana* class in doing away with 8-inch guns in order to increase the number of lighter guns, it is not believed that the power of the ship as a fighter will suffer. The main battery will consist of four 13-inch rifles mounted in two turrets, fore and aft, and fourteen 6-inch rapid-fire guns arranged in broadside. The secondary battery comprises sixteen 6 pounders, four 1-pounders, four machine guns and one field gun.

The engines are of the triple-expansion type and they drive twin screws. The cylinders will be 34, 50 and 78 inches in diameter, and have a stroke of 48 inches. To generate the steam necessary to develop the required horse power there will be eight large boilers with a total grate surface of 685 square feet. The working pressure will be 180 pounds. The armor belt will be of Harveyized steel 16½ inches thick and 7½ feet deep.

Statistics recently published at Munich show that there are in operation in Central Europe, 15,644 gas engines aggregating 52,694 horse power.

The Spontaneous Ignition of Coal.

The following interesting extract is taken from *Kuhlow's German Trade Review*, and it is interesting to notice that Professor Dr. Medem traces spontaneous ignition to the oxidation of iron pyrites, and as no coal is entirely free from this sulphide of iron, the cases the doctor brings under notice become all the more interesting.

Professor Dr. Medem, in the course of a treatise on the spontaneous combustion of hay and coal, gives the following account of the causes this phenomenon and methods that have been proposed for its prevention and suppression.

The simplest form of spontaneous ignition is exhibited by dry spongy platinum, and is due to the absorption and condensation of oxygen in the pores of the metal. When exposed to a current of hydrogen gas, chemical combination immediately sets in, raising the temperature sufficiently to ignite the stream of hydrogen.

In the case of charcoal, a pyrophoric tendency is only manifested when some of the volatile hydrocarbons have been left behind in the distillation process and enter into combination with absorbed oxygen. If, however, such charcoal be freely exposed to air, the external portions speedily lose this property, owing to the pores becoming saturated with air, but it will regain its pyrophoric character if powdered so that the internal layers are enabled to absorb oxygen. As the process of chemical combination always goes on in the interior of a heap, the best way to arrest it is to spread the charcoal out. since attempts at ventilation by blowing or drawing air through the mass will only result in increasing the combustion. Every time the charcoal is broken up the danger of ignition will recur, down to the time it is ground to powder, but powdered charcoal once "killed" by exposure to air never regains its pyrophoric properties.

Hard coals, brown coals and the like are subject to two dangers, explosion and ignition, each having a separate cause. Explosion is due to the liberation of fire-damp following on a decrease in atmospheric pressure, whereas ignition results from the oxidation of the iron pyrites contained in the coal. when exposed to the action of oxygen and moisture. The danger is the greater the finer the state of division of the coal, and coal stacked above ground is particularly liable. Attempts made to reduce the danger by ventilating the stacks have failed in this case also, on account of the increased amount of oxygen thereby introduced into the interior of the mass, and accordingly the coal is stacked as tightly as possible in order to exclude air. Strangely enough, the practice of ventilating the coal bunkers of ships has not been altogether abandoned, notwithstanding Liebig's impressive warning given as far back as 1866, and neglect in this particular has frequently led to lamentable fatalities. Since 1865 no less than 97 coal laden vessels have been destroyed and the lives of some 2,000 seaman sacrificed through spontaneous ignition of the cargo.—*Colliery Engineer.*

Central Railroad Club.

At the September meeting of the Central Railroad Club the Committee on Car Roofs made a report, also the Committee on Planished Iron vs. Plain Sheet Iron or Steel for Locomotive Boiler Jackets. Part of the latter report is as follows:

We find that the difference between the first cost in material of planished iron and plain sheet iron or steel, for the jacket of an engine, to vary considerable, running from $21.61 to $37, in favor of the plain sheet-iron or steel jacket.

We also find practically the same difference between the total cost of labor and material of the planished iron and plain sheet iron or steel jacket, as applied to an engine, the difference running from $20.14 to $37, in favor of the plain sheet-iron or steel jacket.

The life of a planished iron jacket when placed on a good boiler covering, and with proper care taken of it, would be from eight to ten years, and during this time, when the gloss is worn off, or the condition of the jacket should warrant it, it can be then painted, and be maintained at the same cost as the sheet-iron or steel jacket.

We have no information or facts showing the life of a sheet iron or steel jacket.

The cost of maintenance is a difficult question to answer. The planished iron jacket is cared for by the fireman, and he must use some material to keep it clean and protect the jacket from injury from water and drippings from roundhouse, etc., and we are strongly of the opinion that the cost of material to take care of the planished iron jacket will keep a sheet-iron or steel jacket painted. We find from the replies received that to keep the sheet-iron or steel jacket in good condition, they will require two coats of paint a year, at an annual cost of about $5.

This report and the one on car roofs (which we have not yet received) will be discussed at the next meeting. The report on tool, rooms presented at the May meeting was passed without discussion. The new interchange rules were discussed at some length from which it appears that rulings of the Arbitration Committee on certain matters is required at once. There is a conflict of opinion in regard to the interpretation of the rule covering "wrong repairs." A resolution was passed as follows.

"When cars are interchanged having M. C. B. repair cards attached, and also having improper repairs not covered by M. C. B. defect cards, that the repair card be sufficient authority to pass the car to the owning road; and, further, that cars in interchange found with improper repairs and no M. C. B. repair card or defect card attached, that the policy now outlined at Buffalo is to take a record of such wrong repairs when it is possible to distinguish them and that record shall be all the evidence necessary and that all the action necessary at any interchange point to pass that car home to the owning road."

Section 48 of Rule 3 will be interpreted by the members as though the word "simultaneously" had been printed before the last two paragraphs.

President Bronner announced the following subjects and committees for the meeting in November:

"What is the best plan to bring about the adoption of M. C. B. standards by railroads?" Committee: A. M. Waitt, G. W. West, R. S. Miller, James Macbeth, William McWood, John S. Lentz.

"Apprentice boys in railroad shops." Committee: S. Higgins, M. L. Flynn, E. D. Nelson, W. G. Taber, N. Lavery, John Mackenzie.

H. H. Perkins, Local Freight Agent of the New York Central, is also to read a paper on this topic: "Shall the cubic capacity of ordinary box cars be increased, and if so, what should be the maximum limit?"

American Society of Irrigation Engineers.

The annual meeting of this society will be held in Denver, Dec. 11 and 12, closing in time to reach Phœnix for the opening of the International Irrigation Congress on the 15th of that month. At the meeting State Engineer Mead, of Wyoming, will present a paper on "Land Laws for Arid Regions." "Pipes vs. Flumes" will be another principal subject. These papers will be priuted and distributed in advance for discussion, and a circular will also shortly be issued giving full particulars of the programme for the meeting. J. S. Titcomb, Jacobson Building, Denver, is secretary.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued from Page* 234.)

We thus see without any further explanation that with the smaller nozzle distances the shallowest (.31-inch) bridge is the better: at greater distances the second and at the greatest distances the deepest or 1.89-inch bridge is the best. The conclusion to be drawn from this is that with the .31-inch bridge the angle of deflection for the portion of the steam jet above the nozzle, and consequently its sectional area, is greater than that of those varying from .63 inches to 1.89 inches in depth. A larger sectional area of the jet must, with a shorter nozzle distance, force the vacuum more strongly than one of a smaller area would do, but it also fills the smallest sectional area of the stack more quickly, and consequently will begin to drop away from the full value of the vacuum earlier than a jet of smaller sectional area. This explains the earlier attainment of the highest point and also the earlier dropping away of the curve as compared with that of the bridges .94 inch and 1.89 inches deep.

If, in the graphical representation under II. of Plate VII., those nozzle distances fall short of giving the better results, especially in connection with the shallow bridge and the funnel-shaped stacks than they do for the waist stacks, the reason is to be found in the fact of the bad connection of the steam and the entrained air, as was explained at the close of Section IV.

Finally an effort was made to determine whether it were better to have the top of the bridge flush with the top of the nozzle or allow it to project above the same. For this purpose the two nozzles shown in Fig. 62 were used. Their diameters were 5.12 inches and 4.94 inches respectively, and while they had the same free opening, the bridges were set at different heights. The results are given in Plate VII. under III. We see that a somewhat better result was obtained with the flush bridge, which is due to the greater surface of the jet of steam issuing from the nozzle 5.12 inches in diameter.

VIII.—FORM AND DIVERGENCE OF THE STEAM JET.

In order to accurately determine the effect of the bridge upon the shape of the steam jet and thus draw a correct conclusion regarding the cause of the increase of draft as well as the lessening of the same by a contraction of the stack, an investigation was made to ascertain what might be the form and size of the steam jet issuing from the nozzle of the apparatus. It was accomplished by using the rings that had been employed for changing the nozzle positions and setting them on top of one another, the lowest first and so on up to the highest, and then putting the lowest on this, and at each change allowing steam to blow out under the same pressure as in the smokestack experiments. This showed that the lower portion of the jet for a length of about 19.68 inches is in the form of a smooth truncated cone, which from measurements taken near the nozzle opening has a somewhat sharper flare than at greater distances, as shown by the last column of table XXV., and which further on appears to become first weaker and then rougher and more broken up on the outer surface.

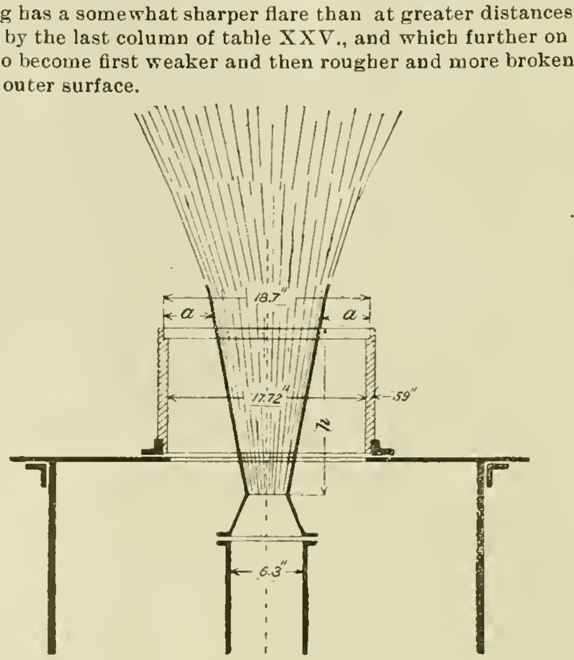


Fig. 63.

The distances, indicated by a in Fig. 63 from the edge of the ring to the steam jet, were now measured at four points that were opposite each other, and this was done for the different heights of rings up to 25.79 inches above the nozzle opening, and from it the diameter of the steam jet was calculated at four different heights. The last was found to be in exactly the same condition within the ring as in the smokestack experiments. These measurements were taken for all fine nozzle diameters, and it was found that the diameter of the jet increases with the increasing diameter of the nozzle opening as that diameter itself increases. The jet on leaving the nozzle has the same diameter as the latter; at least no difference could be detected.

The shape of the jet undergoes almost no change at different steam pressures; with the higher pressure the lower smooth portion is merely lengthened a trifle, which means that the broken surface of the outside appears at a somewhat greater distance from the nozzle opening. The relation of the stack to the different nozzle pressures is dependent upon this very fact, as we have already explained iu Section II.

The five foregoing measurements of the steam jet are grouped together in Table XXIV., from which the averages for the jet diameters as given in Table XXV. are obtained.

It will be seen from these tables that exact measurements amid that loud and almost intolerable noise of a large steam jet was not practicable, since it was not possible to bring the rule in direct contact with the rapid current of exhaust steam. This explains the difference between the bracketed figures and the actual maximum measurements of Table XXIV.

According to Table XXV. the diameter of the section of the jet for all five nozzles increases in an arithmetical ratio with them, so that, at the same heights, the section is increased by the same coefficient. At a distance of 25.79 inches from the nozzle this increase in all five cases amounts to 10.67 inches, from which we see that the average flare of the jet is

$$1 : \frac{25.79}{10.67} = 1 : 2.41,$$

which means that the conical sides of a continuous current of steam are inclined to a vertical at an angle of 1 in 4.8, as shown in Fig. 64.

Figure 65 shows the form of a jet as it issues from a nozzle 4.72 inches in diameter. If this is drawn full size and the outlines a c and b d plotted, it will be seen that these latter vary only very slightly from the actual outlines. The sharpest relative flare naturally occurs in the lower portion of the jet, which is shown by the last column of Table XXV. to be 1 in 2.2 instead of 1 in 2.4. At a height of 15.75 inches the flare of the outer surface becomes 1 in 2.34, and at 19.68 inches it is 1 in 2.39. Now, since in the general

*Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen*.

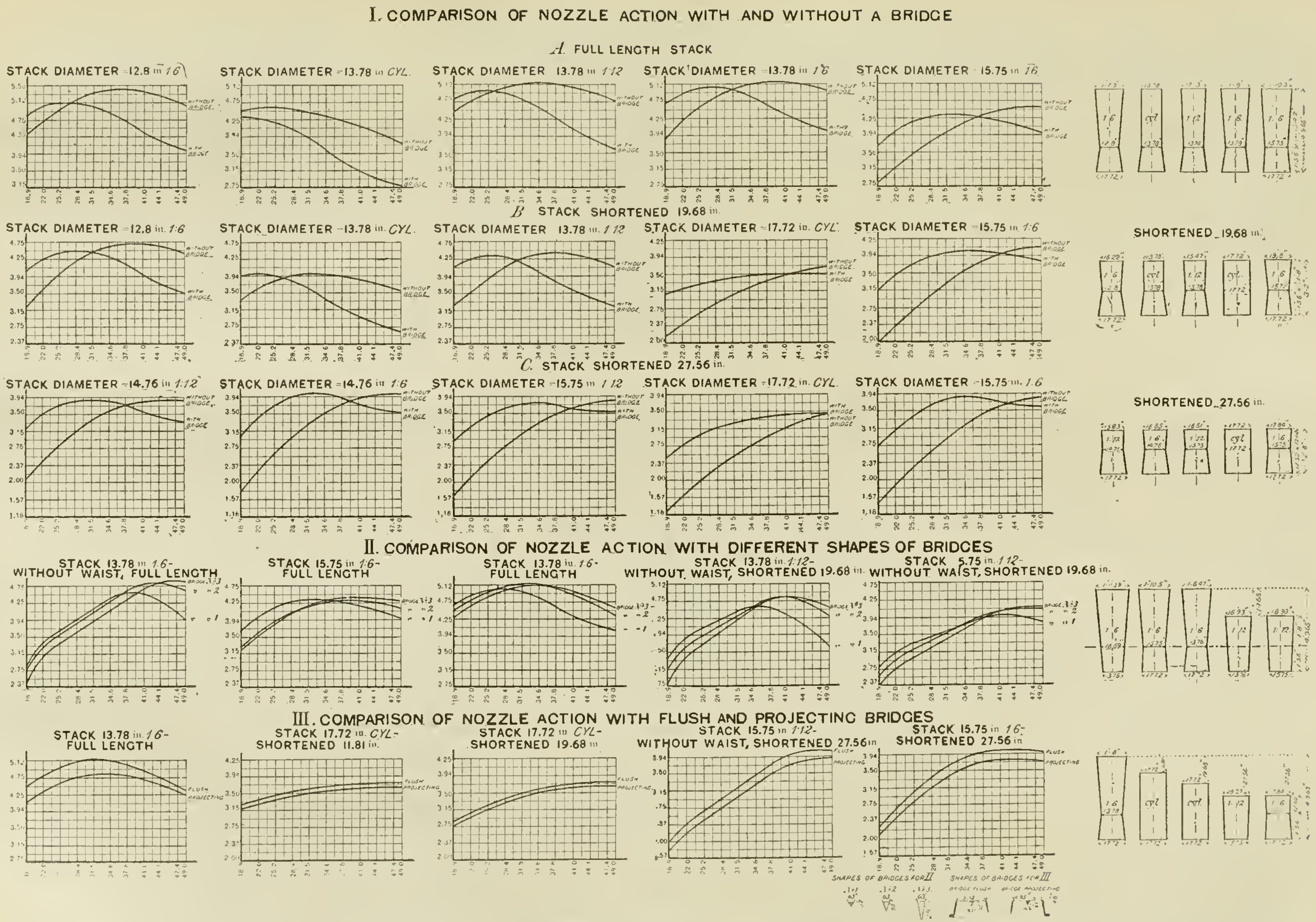


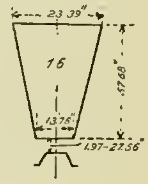
PLATE VII.—DETAIL DIAGRAM OF THE HANOVER SMOKE STACK AND EXHAUST NOZZLE EXPERIMENTS.

Remarks.—1. The abscissas, which indicates the nozzle distances, for stacks that have no waist and for the cylindrical stacks 17.72 inches in diameter, are measured from a zero point 17.52 inches above the smallest cross section which is at the bottom of the stack proper, and 18.9 inches above the highest position of the nozzle.

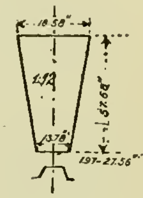
2. In the experiments tabulated under I., the nozzle without a bridge had a diameter of 1.74 inches, while that of the one with a bridge was 5.12 inches. The width of the bridge was .63 inches and the depth .31 inches. Both nozzles had the same free opening.

TABLE XXIII.

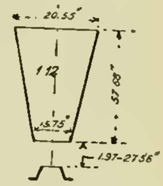
1.—STACK 13.78 INCHES DIAMETER, ⅙ FLARE, NO WAIST.

Distance of nozzle from bottom of stack, inches.	Length of Stack.								Remarks.
	Full length (4 ft. 9.68 in.).		Shortened 11.81 in. (3 ft. 9.87 in.).		Shortened 19.68 in. (3 ft. 2 in.).		Shortened 27.56 in. (2 ft. 6.12 in.).		
	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water column, inches.	Per cent.	
1.97	+.67	28.8	+ 86	41.9	+.91	58.5	1.10	90.3	
3.94	.73	28 0	.91	40.7	.99	50.5	1.19	79.6	
7.87	.69	22.7	.87	32.3	.94	40.0	1.12	57.5	
11.81	.63	18.6	.81	26.4	.87	31.0	1.01	43.4	
15.75	.57	15.1	.75	21.6	.79	24.3	.94	33.1	
19.68	.39	9.4	.57	14.8	.59	16 2	.77	23.0	
23.62	.00	0.0	+.12	2.7	+.15	3.6	+.29	7.7	
			(0 @ 24.57)		(0 @ 24.73)		(0 @ 25.71)		
27.56	—.55	......	—.43	......	—.39	......	—.24	......	

2.—STACK, 13.78 INCHES DIAMETER, 1⁄12 FLARE (WITHOUT WAIST).

Distance of nozzle from bottom of stack, in.	Length of Stack.								Remarks.
	Full length (4 ft. 9.68 in.).		Shortened 11.81 in. (3 ft. 9.87 in.).		Shortened 19.68 in. (3 ft. 2 in.).		Shortened 27.56 in. (2 ft. 6.12 in.).		
	Water column, in.	Per cent.	Water column, in.	Per cent.	Water column, in.	Per cent.	Water column, in.	Per cent.	
1.97	.45	12.7	+.69	22 8	+.94	36.6	1 09	56.7	
3.94	.39	10.1	.60	17.5	.85	28.6	1.05	46 1	
7.87	.29	6.9	.52	13.8	.75	22.0	.98	35 5	
11.81	.24	5.2	.41	10.1	.63	16.9	.88	27.8	
15.75	.18	4.1	.33	7.6	.50	12.3	.75	21.0	
19.68	+.03	.0	.16	2.1	.17	3.8	.38	9.5	
	(0@20)		(0@20.79)		(0@21 26)		(0@22.64)		
23.62	—.31	... .	—.29	......	—.28	......	— 12	......	
27.56	—.71	......	—.75	......	—.75	......	—.61	......	

3.—STACK 15.75 INCHES DIAMETER, 1⁄12 FLARE (WITHOUT WAIST).

Distance of nozzle from bottom of stack, inches.	Length of Stack.								Remarks.
	Full length (4 feet 9.68 inches).		Shortened 11.81 inches (3 feet 9.87 inches).		Shortened 19.68 inches (3 feet 2 inches).		Shortened 27.56 inches (2 feet 6.12 inches).		
	Water column inches.	Per cent.	Water column inches.	Per cent.	Water column inches.	Per cent.	Water column inches.	Per cent.	
1.97	.52	17.7	.80	33.2	1.00	53.1	1.11	88.2	
3.94	.48	15.5	.75	28 8	.98	46.7	1.10	72 7	
7.87	.42	12.8	.65	22.3	.89	36.0	1.06	55 1	
11.81	.36	10.2	56	17.8	.78	28.2	.98	43.1	
15.75	.29	7.8	.47	13.8	.66	21.4	.92	34.7	
19.68	.24	6	.37	10.2	.54	16.2	.79	26.1	
23.62	.08		.19	4.6	31	8.6	.51	15.3	
	(6 @ 25.2)		(0 @ 26.77)		(0 @ 28.19)		(0 @ 29.92)		
27.56	.15		.06		.05		.20	5.4	

4.—STACK 15.75 INCHES DIAMETER, ⅙ FLARE (WITH WAIST).

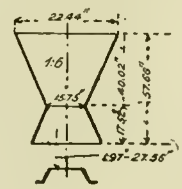
Distance of nozzle from bottom of stack, inches.	Length of stack.								Remarks.
	Full length (4 feet 9.68 inches).		Shortened 11.81 inches (3 feet 9.8 inches).		Shortened 19.68 inches (3 feet 2 inches).		Shortened 27.56 inches (2 feet 6.12 inches).		
	Water column, inches.	Per cent.	Water column, inches.	Per cent.	Water Column, inches.	Per cent.	Water Column, inches.	Per cent.	
1.97	.86	29.4	....	—	1.19	58.7	1.30	84.6	 No experiments were made with the bridge in connection with a stack shortened 11.81 inches.
3.94	.86	27.5	....	....	1.18	52.6	1.27	71.6	
7.87	.76	21.6	....	....	1.06	39.4	1.18	52.6	
11.81	.53	13.8	....	....	.88	28.1	1.04	39.0	
15.75	.26	6.2	....	....	.60	17.3	.79	25 6	
19.68	.0	....	....	....	.28	7.6	.43	13.0	
					(0@24.25)		(0@25.67)		
23.62	— .24	....	....	....	+ .04	....	+ .14	3.7	
27.56	— .44	....	....	....	— .16	....	— .09	....	

TABLE XXIV.

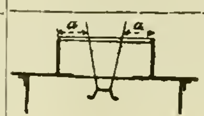
Distance of the meas'd section from the nozzle.	Amount of the distance *a* with a nozzle diameter of—					Remarks
	3.91 inches.	4.33 inches.	4.72 inches.	5.12 inches.	5.51 inches.	
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	 The bracketted figures form the basis of Table XXV. The other are working dimensions.
5.51	6.10 to 6.30 (6.14)	6.02 (5.95)	5 71 (5.75)	5 51 (5.55)	5.32 to 5.57 (5 35)	
10.16	5.12 to 5.32 (5.15)	4.91 (4.93)	4.61 to 4.71 (4.78)	4.53 (4.57)	4.33 (4.37)	
14.16	4.33 to 4.55 (4.33)	4.13 to 4 33 (4.13)	3.74 to 3.91 (3.94)	3.54 to 3.74 (3.74)	3.62 (3.54)	
18.03	3.54 to 3 74 (3 62)	3.35 to 3.54 (3.43)	3.15 to 3.35 (3.23)	3.15 to 3.27 (3.03)	2.76 (2.83)	
25 79	2.17 to 2.36 (2.05)	1 77 (1.85)	1.57 (1.65)	1.38 to 1.57 (1.46)	1.18 to 1.38 (1.26)	

TABLE XXV.

Distance of the measured section from the nozzle.	Diameter of the steam jet with a nozzle diameter of					Flare of the steam jet.
	3.94 in.	4.33 in.	4.72 in.	5.12 in.	5.51 in	
Inches.	Inches	Inches	Inches	Inches	Inches	
5.51	6.41	6.81	7.21	7.60	7.99	1 in.@2.22
10.16	8.39	8.78	9.17	9.57	9.96	1 " @2.28
14.17	10.04	10.43	10.83	11.18	11.61	1 " @2.32
18.03	11.46	11.80	12.24	12.61	13.03	1 " @2.39
25.78	14.61	15.00	15.39	15.79	16.18	1 " @2.41
Total increase in diameter.	10.67	10.67	10.67	10.67	10.67	

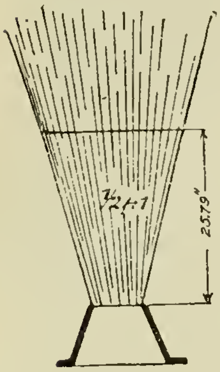


Fig. 64.

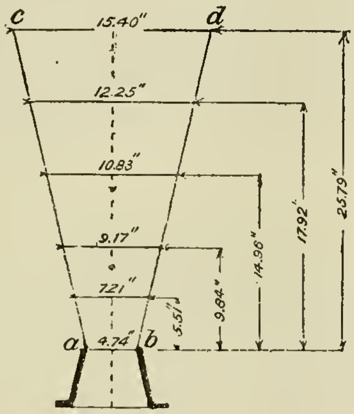


Fig. 65.

practice on modern standard gage locomotives, it is scarcely possible to put the nozzle at a shorter distance than 15.75 inches, we may consider that, for all practical purposes, the flare of the exhaust is 1 in 2.4.

This is then readily applicable to all nozzle distances up to 27.56 inches.

Beyond this latter dimension the calculation would no longer be quite as accurate, because the current of steam has its outer surface very much broken up and so fills up a somewhat greater sectional area.

This knowledge of the shape of the jet renders it possible to determine the efficiency of any chosen nozzle distance from the smallest section of the stack, as we have already shown in what proceeds. If we base our calculations upon a flare of 1 in 2.4, the corresponding distance at which the smallest cross-section of the stack is just filled by a continuous jet of steam is shown in the following table for the several nozzle diameters:

Smallest diameter of stack.	Nozzle diameter.	Distance from nozzle at which the stack is filled.
11.81 inches.	3.94 inches.	1 foot 6.90 inches.
12 80 "	4.33 "	1 " 8.32 "
13.78 "	4.53 "	1 " 10.21 "
14.76 "	4.91 "	1 " 11.62 "
15.75 "	5.12 "	2 " 1.51 "

If we also make a comparison of this with the lines of the diagram of Plate I. we will see that the that the abscissas given in the last column are approximately the same for the given nozzle diameters and turn slightly to the horizontal, while for the shorter abscissas they are almost straight. Had the experiments been made with waist-shaped stacks with nozzle distances of 18.9 inches and a diameter of 3.94 inches it would doubtless have shown that the lines would have been very similar in their lower portions to those of the funnel-shaped stacks, which means that they would have been approximately straight. This explains the reason why there is a sharp curvature of the lines of the diagrams and their final dropping down toward the axis of the abscissas at the greater nozzle distances.

IX.—Influence of the Bridge on the Form of the Steam Jet.

In the same manner as we described in VIII. the different sections of a stream of steam issuing from a nozzle with a bridge were measured. The nozzle had a diameter of 5.12 inches, the bridge was .63 wide and .31 inches deep. We found, in the first place, that the circular cross-section of the jet had been changed into an ellipse by the bridge, into which the longer axis lay at right angles to the bridge.

Fig. 66 shows such a section of the jet by the cross-hatchet lines for a height of 18.07 inches. The outer circle shows the ring used for the measuring; the dimensions given are those from which the axis of the ellipse were located.

It is thus seen how the wedge-shaped surface of the bridge causes the steam to make a sharp deflection at right angles to its length, while in the direction of its axis there is a smaller variation from the circular section that is quite noticeable, as is shown in Table XXVI.

TABLE XXVI.

Distance of the measured section from the nozzle opening.	Major Axis.			Minor Axis.		
	Distance *a*.	Diameter of steam jet.	Flare of the side of the cone.	Distance *a*.	Diameter of steam jet.	Flare of the side of the cone.
inches.	inches.	inches.		inches.	inches.	
0	0	5.12	....	0	5.12	....
10.16	2.76 to 2.95=(2.95).	12.80	1 in 1.3	4.53 to 4.72=(4.65).	9.25	1 in 2.36
18.03	.39=(39).	17.92	1 " 1.4	2.95 to 3.15=(3.03)	12.64	1 " 2.4
25.79	—.79 to .98=—(.98).	20.67	1 " 1.65	1.57 to 1.77=(1.65).	15.32	1 " 2.5

With this form of bridge we may consider that the average flare of the current of steam in the direction of the longer axis is from 1 in 1.5 to 1 in 1.6 and that in the direction of the shorter it ranges at about 1 in 2.45 as shown by Fig. 67.

Fig. 66.

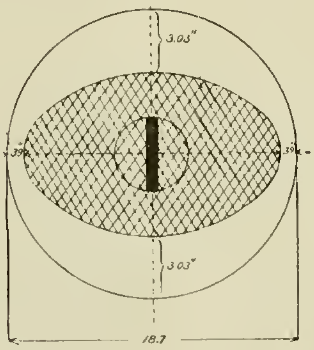


Fig. 67.

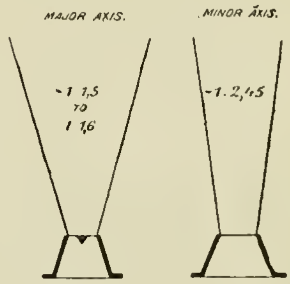
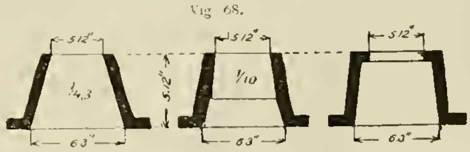


Fig. 68.



In consequence of this elliptical section the external surface of such a jet of steam has a greater area and fills the section of the stack much earlier, that is to say at a lesser distance from the nozzle opening, than would be the case with a steam jet of the same size but of circular section. Hence by an application of the bridge to a nozzle having the same free opening we have:

1. A better indraft of air or products of combustion on account of the greater surface area of the jet.
2. And also a more effective height of stack, because of the fact that the section is filled earlier on account of the elliptical form of the jet.

It may also be mentioned that with a nozzle distance of 25.79 inches the jet of steam struck against the upper edge of the ring on a line with the major axis, so that the measurement *a* became negative and should be reckoned at from .79 to .98.

Another result of the earlier filling of the section of the stack is shown in the fact that the apparatus began to throw water earlier, and that upon the locomotive spark-throwing also appeared earlier.

This shows us that the bridge is not applicable to great nozzle distance, and in general with stacks like those used on the experimental apparatus there is a throwing of water as indicated in table XXI.

(To be continued.)

New Publications.

Poor's Manual of the Railroads of the United States. 1896. H. V. & H. W. Poor, 44 Broad street, New York. 1,669 pages, 6 inches by 9 inches. Price, $7.50.

The publishers of this well known manual in 1898 consolidated with it "Poor's Handbook of Investment Securities." As a result the volume before us includes state and municipal investments, industrial securities, etc. It has 258 more pages than the 1895 edition, and contains statements of 2,040 steam railroad companies, 1,208 street railroads, 143 industrial corporations, and 1,008 state, county, city, town, etc., debts—in all 4,399 corporations, aggregating $16,475,000,000. The labor and expense of such a work can in a measure be appreciated from these figures. Notwithstanding the wider scope of this accurate work its price remains as heretofore.

Report of the Proceedings of the Thirteenth Annual Convention of the Master Car Builders' Association, 1896. Pages, 6 inches by 9 inches. (John W. Cloud, Secretary, Chicago Ill.)

This volume needs no extensive notice by us. It appears in its usual form, is well bound, and is much larger than any previous report of the association. It contains much valuable information, as is always the case with the proceedings of this society.

Baker's Railway Magazine. Monthly. Published by Geo. H. Baker, Metropolitan Building, New York. $3 00 per year.

The first number of this new magazine appeared last month and a copy is before us. It contains a number of interesting articles by men well known in railroad circles, and is good reading. If future issues can be maintained on the same plane as this first one the publication ought to, and, we hope, will succeed. As an inducement to prospective subscribers an art supplement (reproduced on a small scale in the first number) is for the present given with each subscription. The central figure is a woman, who ought to improve her form or else wear more clothes.

The Practical Engineers' Pocket Book and Diary, 1896. Edited by William H. Fowler. *Technical Publishing Company, Limited*, Manchester, England. 404 pages. 3⅝ by 5½ inches. 1s. 6d.

A "Pocket Book" or a dictionary always fill a reviewers mind with dispair as it is almost impossible to give an idea of their characteristics in a notice as brief as a review must necessarily be. In the present instance a nice enumeration of the subjects treated would occupy more room than can be given to the book. It begins with 19 pages of mensuration and tables, etc., which are common to all publications of this class. The next 42 pages are devoted to steam boilers in which a great variety of information is given relating to their construction and operation. This and the succeeding 79 pages devoted to the steam engine are the strong features of the book. After these chapters there are articles on the indicator, transmission of power, gas and oil engines, hydraulic and lifting machinery, friction, cutting tools, gearing, notes on heat, nickel steel, aluminum pipes, bolts and nuts, strength and weight of various materials. A feature in the latter part of the book which indicates the advance which has been made in certain directions is notes on electrical engines by S. T. Harrison, which occupies 50 pages. Notes on patents and patent law and a blank diary complete the book.

Report of the Proceedings of the Twenty-Ninth Annual Convention of the American Railway Master Mechanics' Association, 1896. 365 pages, 6 inches by 9 inches. (John W. Cloud, Secretary, Chicago, Ill.)

The contents of this volume are already familiar to our readers through the report of the proceedings given in our July issue. The members will be gratified at the improvement in the binding of this volume as compared with preceding ones. It is in cloth instead of paper covers and is exceedingly neat in appearance. The plain black, relieved only by the title in gilt on the binding, is a relief from the gaily-colored designs with which each volume has been decorated in recent years, and is more in keeping with the dignity of the association.

The Universal Directory of Railway Officials, 1896. *Compiled from official sources.* By S. R. Blundstone, Editor of the Railway Engineer. Price, 10 shillings. The Directory Publishing Company, Ltd., 8 Catherine St., Strand, W. C., London. 374 pages, 5½ inches by 8½ inches.

This book, less than one inch thick, contains information which cannot be obtained from any other single volume published and is what its name indicates—a universal directory. Of course it does not list the very small roads in this or other countries, but its selection of roads for publication has apparently been carefully made, and few persons would have occasion to write to officials outside of their own countries whose address cannot be found in this work. A few omissions might be noted, one being that not an operating, purchasing or mechanical official of the Southern Railway is listed, but on the whole it is an excellent compilation.

Books Received.

Bulletin of the Department of Labor, No. 5. July, 1896. Edited by Carroll D. Wright, Commissioner. Washington; Government Printing Office. 1896. 122 pages.

Iron Making in Alabama. By William Battle Phillips, Ph. D., Consulting Chemist Tennessee Coal, Iron & Railroad Company, Birmingham, Ala. Issued by the Alabama Geological Survey, Eugene Allen Smith, Ph. D., Director. 1896.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

Catalogue "B." *Rue Manufacturing Company*, 116 North Ninth Street, Philadelphia, Pa., U. S. A. Injectors, 1896. 12 pages, 6 inches by 9 inches. (Standard size.)

This company manufactures the well-known "little giant," "fixed nozzle" and "unique" injectors, Rue's patent boiler-washing and testing apparatus, ejectors, and other jet apparatus, steam valves and boiler checks, and this catalogue is descriptive of these devices. These are illustrated and described, directions given for their application and use, and tables of size, capacity and price afford the information the purchaser desires. Catalogue "B" is a railway edition, and those desiring information about stationary injectors should write for catalogue "A."

Electric Locomotives—Baldwin Locomotive Works, Burnham Williams & Co., Philadelphia, and the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. By David Leonard Barnes, Consulting Engineer. 123 pages, 6 inches by 9 inches. (Standard size.)

While largely descriptive of the electric locomotives that these companies have built jointly or are prepared to build, the book also contains much valuable information on electrical apparatus, presented in a way that makes it easily understood by practical mechanically trained men who have but little knowledge of electricity. Electric locomotives for passenger, freight, switching, elevated and suburban and mine traffic are illustrated, as are also the trucks, motors and controllers for them. Diagrams of horsepower, torque, speed and efficiency of motors are given, a form of specification, an outline of data required for a preliminary estimate of the cost of electrical equipment, a glossary of electrical terms and a chapter explaining "why an electric motor revolves" complete the work. In another part of this issue will be found a part of the last named chapter. The engravings and press work are of the best.

Recent Engineering Work. Ford & Bacon, Engineers. 28 pages. 9½ by 13½ inches.

This is a handsome publication containing illustrations and descriptions of engineering work recently completed by this firm of engineers. Included in it are articles on the system of the Orleans Railroad, of New Orleans, La., the Bergen County Traction Company, in Bergen County, N. J., and an instructive article on steam piping for electric railway power plants. The illustrations show up many valuable details. This firm takes entire charge of all engineering details of construction of electric railways, including all civil, mechanical and electrical engineering connected with the work, preliminary surveys and estimates, etc. They have offices in the *Mail and Express* Building, New York; Philadelphia Bank Building, Philadelphia, and the Morris Building, New Orleans.

Imperial German Drawing Instruments. *Thos. Alteneder & Sons, Philadelphia.* 16 pages, 3½ by 6 inches.

This is a current little pocket catalogue describes German drawing instruments which this firm has for sale. The engravings are good and the printing excellent.

Fig. 1.—Lidgerwood Cableway at Hilo, Hawaii.

Fig. 2.—Landing Freight from Steamer, Hilo, Hawaii.

Fior. 3.—Lidgerwood Cableway, Hilo, Hawaii—Tail Tower, Warehouse Wharf and Derricks.

A Lidgerwood Cableway at Hilo, Hawaiian Islands.

We show in the three engravings printed herewith an interesting and somewhat unusual installation of the Lidgerwood cableway at Hilo, Hawaiian Islands, where it is used by the Onomea Sugar Company for transporting sugar, lumber and general freights.

The coast at this point is a rough one, and it is a matter of much difficulty to convey material to and from vessels and the wharf, this being done by using small boats, as shown. The sugar or other freight is hoisted from the small boats by a number of derricks placed upon the wharf and afterward carried by the cableway up the hill to a point at the head tower. Or, if it is to be shipped, the cableway takes the material down to the landing, and from there it is transported to the vessel ready to receive it by the small boats. The cableway is of the latest improved Lidgerwood pattern with main cable two inches in diameter. The head tower is 60 feet high; tail tower 50 feet.

The average load handled is two tons. In Fig. 3 the cableway is seen transporting a load of 4,500 pounds of barley.

This cableway was furnished the Onomea Sugar Company through the Pacific Coast agents of the Lidgerwood Manufacturing Company, Messrs. Parke & Lacey Company, of San Francisco, Cal. It was set up by the native workmen at Hilo, without other help from the builders than general instructions.

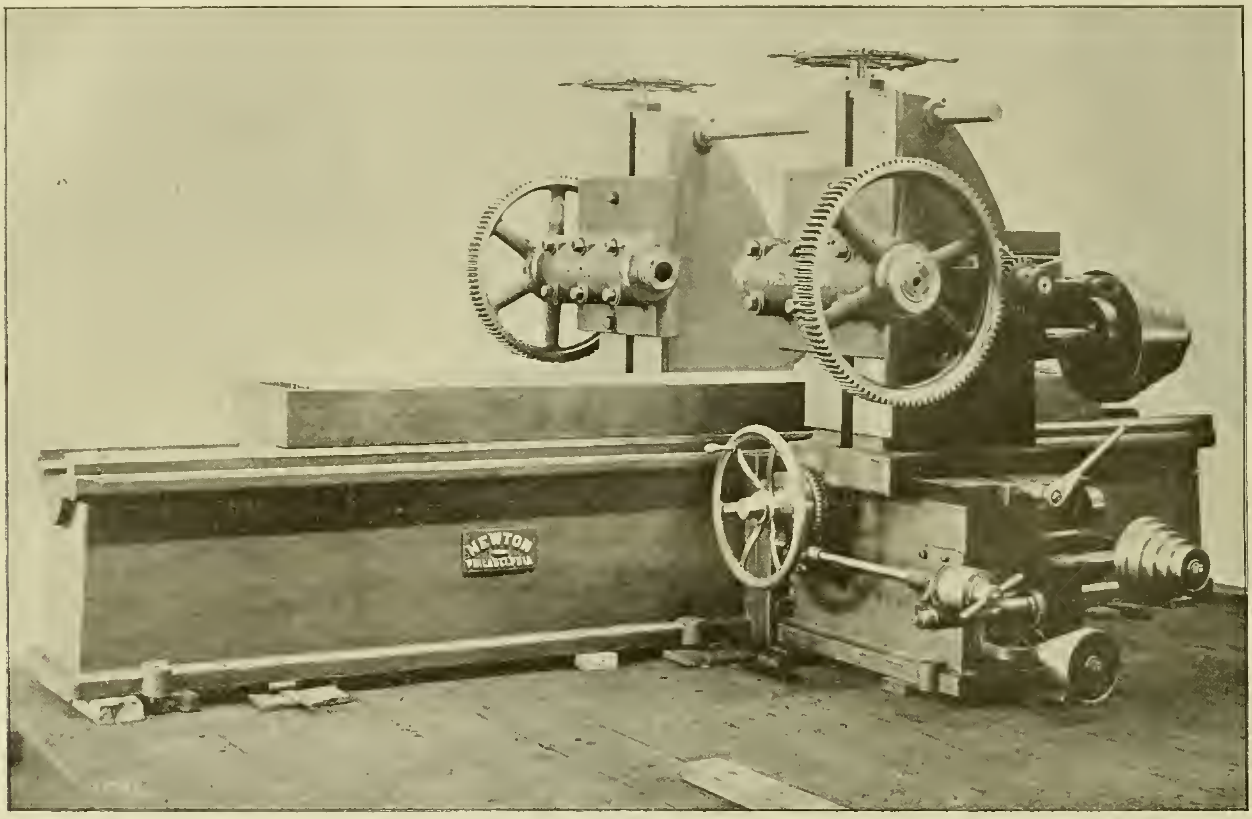
Of its working the Onomea Company say, in a recent letter to the Lidgerwood Manufacturing Company: "You will be glad to hear that the cableway is working perfectly in every way." Where convenience, dispatch and economy in operation are considered, one of the best devices for hoisting and conveying material of all sorts is the Lidgerwood cableway.

Relative Cost of Iron and Copper as Conductors.

The accompanying table, given by Mr. J. R. Allen in *The Technic*, shows the relative cost of copper in cents per pound as compared with wrought iron, Bessemer steel and cast iron in dollars per ton. The comparison is made for conductors having equivalent carrying capacity. In using Bessemer steel rails for conductors it is possible to use those that are winding and imperfect. Such rails may be purchased at a greatly reduced price.

Cost of copper, in cents per pound.	Cost of equivalent wrought iron conduc or, in dollars per ton.	Cost of equivalent Bessemer steel conductor, in dollars per ton	Cost of equivalentcast iron conductor, in dollars per 1oo.
7.	19.25	18.10	14.50
7.5	20.75	19.50	15.50
8.	21.50	20.30	16.75
8.5	23.75	22.25	17.75
9.	25.00	23.50	19.00
9.5	26.50	25.00	20.00
10.	28.00	26.25	21.00
10.5	29.25	27.50	22.00
11.	30.75	29.00	23.00
11.5	32.25	30.25	24.25
12.	33.50	31.75	25.25
12.5	35.00	33.00	26.25
13.	36.50	34.50	27.25
13.5	38.00	35.75	28.50

Consider the saving that can be made by the use of Bessemer rails, assnming the rails to cost $25 per ton, as compared with copper at 11 cents per pound. Let the current to be transmitted be



A Heavy Milling Machine for Locomotive Work—Built by the Newton Machine Tool Works, Philadelphia.

1,000 amperes at 500 volts and the distance it is to be transmitted be three miles with 5 per cent. drop in voltage.

Cost of copper conductors	$39,000
Cost of Bessemer steel conductors	23,711
Difference	$5,289
Deducting $400 per mile for bonding	1,200
Total saving	$4,089
Saving per mile	1,363

The first use of steel rails as conductors was on the intramural road at the World's Fair. The Metropolitan and Lake street Elevated Roads, of Chicago, have adopted steel rails as conductors, as has also the New York, New Haven & Hartford Railroad, on its new extension of the electrical equipment on the Nantasket Beach line, though in the last mentioned case the rails are of special form

The Gas Exposition in New York.

During the two weeks beginning January 25, 1897, there will be held in Madison Square Garden, New York, an exposition that should attract much interest and liberal patronage. It is to be a gas exposition held under the management of the Gas Industries Company, and is the first affair of the kind attempted in this country. In a number of European countries gas exhibitions are a regular feature of each year's entertainments, and at the present Berlin exhibition the gas building is said to be one of the most pleasing and at the same time a very interesting exhibit.

The exposition in New York will be managed by a board of directors, assisted by an executive committee. It is comprised of men familiar to the commercial and financial world, whose names are a guarantee that this project will be a complete success in every particular. The executive committee will come in more direct touch with exhibitors. As appointed that body consists of the following gentlemen :

E. C. Brown, Chairman; W. H. Bradley, Chief Engineer Consolidated Gas Company of New York; Col. W. E. Barrows, President Welsbach Light Company; Walton Clark, General Superintendent United Gas Improvement Company, Philadelphia; Emerson McMillin, President The Gas Companies of St. Louis, Milwaukee, Columbus (O.) and Grand Rapids (Mich.). The offices for the present will be located at 280 Broadway, Rooms 237-8, where applications for exhibition spaces can be made or information of any character relating to the exposition be obtained.

The interest in the methods of gas manufacture, the qualities of gas and the appliances utilizing it for various purposes is great enough to ensure the success of the project from a mechanical standpoint, particularly under the excellent management of the present board of directors, and it should also be possible to make the exhibits equally interesting and instructive to the general public.

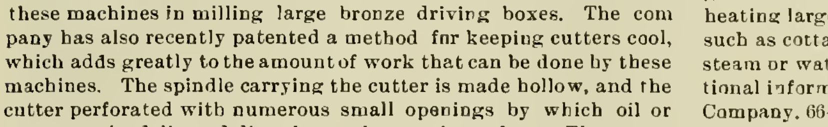
A Heavy Milling Machine for Locomotive Work.

The tendency toward a heavier construction of milling machines for railroad shop use is strikingly illustrated by the tool built for the new Russian-American Locomotive Works of Nijni Novgorod, Russia, by the Newton Machine Tool Works, of Philadelphia, and illustrated in the accompanying engraving. This machine is called by the builders their "No. 6 duplex milling machine," and is an advanced type of this line of tools. These duplex machines were designed in 1885, and intended principally for locomotive work. The first built were the No. 4, which weighed about 10,000 pounds. The requirements of milling machines increased and the company placed on the market a larger size, which was classed as the No. 5. When Mr. Dixon, the Chief Engineer of the Sormovo Company (of which the new locomotive works is a part) was investigating the merits of milling machines, he decided upon one of still heavier construction, namely the No. 6. This can be used for milling and completing drivingboxes, milling two sides at one time, milling out for the shoes and wedges and milling the inside to admit the cellar. These are the heaviest requirements of the machine. On rod work the machine can be used for panelling by removing the face cutters and using two ordinary panelling cutters on the end of each spindle, two rods can be panelled at one time. With flat rods, an ordinary heavy cutter can be used, one head then acting as a live head and the other as a tail support for the arbor. This machine is of an exceptionally heavy design. Its total weight, with a carriage to mill 11 feet long, is 35,000 pounds. The spindles of the machine are 6 inches in diameter, the carriage 23 inches wide and 12 feet long to mill 11 feet in length. The spindles can be raised 26 inches from centre to carriage and will admit work 45 inches wide between the facing heads. The spindles are driven with large spur gearing; the driving pinion shaft, has a phosphor bronze triple lead worm wheel which is driven by a Harveyized steel worm, with the thrust collars of phosphor bronze and Harveyized steel. With this arrangement, an enormous power is given to the spindles and the machine is capable of handling the heaviest classes of work The feed is suitable for the modern requirements of milling and has a range of from ½ inch to 10 inches per minute. The carriage of the machine is fed with a rack and spiral pinion, and has a quick power movement in both directions. One valuable feature of this machine is the heavy tie rod which clamps both uprights after. they are set and keeps them from springing apart on heavy cuts Some remarkably heavy work has recently been done on one of these machines in milling large bronze driving boxes. The company has also recently patented a method for keeping cutters cool, which adds greatly to the amount of work that can be done by these machines. The spindle carrying the cutter is made hollow, and the cutter perforated with numerous small openings by which oil or water can be delivered directly on the cutting edges. The water passing through the interior of the cutter helps to keep it cool, and the quantity of it that can be delivered exactly where it will do the most good has an equally beneficial effect. On a recent test a cut $\frac{3}{32}$ inch deep was taken off a piece of forged steel 7 inches wide with a feed of 10 inches per minute, and the cutter remained cool and sharp.

Oil Tube Drills.

The accompanying cut illustrates the style of oil tube drills which are manufactured by the Cleveland Twist Drill Company, Cleveland O. In boring deep holes it is necessary that lubrication of the cutting and bearing surfaces shall be satisfactory, inasmuch as the close packing of the chips will not in such cases admit of proper lubrication by gravitation, and it is necessary to provide other means for forcing the oil down on to the cutting lips. In the drill shown this is accomplished by means of grooves cut just deep enough to admit of enclosing a small brass tube, making a smooth surface as ordinarily provided for in twist drills.

The tubes terminate at the lower ends in openings discharging the oil directly at the cutting edges of the drill. The upper ends of the tubes project from the shank of the drill and through these the oil is inserted. With a high speed and heavy feed, drills heat at the points, as it is impossible to force in a lubricant, and it was to overcome this objectionable feature that these tube drills were placed on the market.



Oil Tube Drills.—Cleveland Twist Drill Co.

There may be several ways of conveying the oil through the tubes; the one recommended is as follows: The tubes are cut flush with the shank end, then a collet placed on the shank which fits the turret. An oil pipe is connected with the center of the turret and carried down to a chamber connecting with the butt end of the drill. The oil is forced through on to the point with considerable force, and assists in sending the chips up the flutes, and at the same time keeps the cutting lips perfectly cool. Collets are made for various-sized drills, and as the outside diameters of the collets fit the turret, a drill can be changed in a few seconds.

The company has already furnished a great many of these tools to turret lathe and bicycle manufacturers, and they are giving excellent satisfaction.

The La Villa Heaters.

The A. A. Griffiing Iron Company has brought out a double line of heaters called the La Villa. We say "double line," since they make them two ways, with ornamental side-plate and base-plate and without. The capacity is the same in both, but of course the price is less for the latter. The La Villa heaters savor of stove construction. They are ornamental and portable and may even be had with removable ashpan. There are ten sizes made for steam and a like number for water, making twenty in all. The company claims a very great amount of direct fire surface, since the entire fire pot is deeply corrugated. In the La Villa the fire has to travel three times the entire length of the heater before reaching the smoke pipe. It is very easily cleaned, for when the front and rear clean-out doors are opened every square inch of the heater is visible and accessible for a thorough cleaning. This is a very important factor in any heater. If a heater can be easily cleaned the chances are that it will be frequently cleaned, and if kept clean the economy of fuel is very marked. The best heater made if coated with the deposits of combustion, which are non-conductive in their nature, is very seriously handicapped.

The La Villa, having a rocking and dumping grate, will burn successfully soft or hard coal, coke or wood, is easily set up, comes practically in three parts, viz.:—base plate, ashpit section with grates already set in, and heater proper. It is not designed for heating large buildings, but for the thousands of small buildings such as cottages, small railway stations, etc., that are heated with steam or water every year and at a surprisingly low cost. Additional information can be obtained by writing to A. A. Griffing Iron Company, 66-68 Centre street, New York; 177-179 Fort Hill square, Boston; 702 Arch street, Philadelphia, or the works at Jersey City, N. J., mentioning this paper.

A patent was issued to the Crane Company, of Chicago, on July 28, for its Safety Valve for the Baker Heater.

The Niles Tool Works at Hamilton, O., will soon ship a large consignment of planers and boring machines to Italy and Austria.

The Vulcan Iron Works, of Chicago, has an order for new steam turning machinery, for the Grassy Point Draw of the St. Paul & Duluth Railroad, at Duluth.

The city of Chicago will receive bids until November 14 for six pumps with a capacity of 20,000,000 gallons in 24 hours. These are to be placed in a new pumping station to supply water to the northwestern section of the city.

The Morgan Engineering Company of Alliance, O., shipped last month 200 tons of machinery to Russia for the new locomotive works there. There were two steam hammers, a hydraulic crane and a hydraulic flanging press.

The Edward P. Allis Company, Milwaukee, Wis., has orders for two cross compound vertical direct-acting blowing engines for export to Austria. They are said to be the largest blowing engines ever built and their weight is about 275 tons each.

The firm of Hoopes & Townsend, of Philadelphia, manufacturers of bolts, nuts, washers, rivets, etc., is particularly fortunate in having its large plant kept pretty busy during such times as these. Two of the shops are running 10 hours per day, and the others seven hours.

At a meeting of the stockholders of the Westinghouse Machine Company held last month, it was decided to increase the capital stock of the concern from $750,000 to $1,500,000, the new capital to be used principally in the development and manufacturing of gas engines.

The Laidlaw-Dunn-Gordon Company, Cincinnati, O., has painted on the roof of its factory, which is 665 feet long, and located close to the Cincinnati Hamilton & Dayton tracks, a sign in letters of gold, 13 feet high, the wording of which is "McKinley, Hobart and Sound Money."

The Rand Drill Company has recently received an order from the Michigan Central Railroad Company for three air compressors for its shops in Detroit and Jackson, Mich., and St.Thomas, Can.; also an order for two air compressors for the Missouri Car and Foundry Company, St. Louis.

Two rock crushers, with a daily capacity of 200 tons each, has just been shipped by the Gates Iron Works, Chicago, to the Coolgardie gold fields of West Australia. The Gates Iron Works also has an order for one of their largest crushers, capacity two tons per minute, for the Basalt Actien Gesellschaft of Kolen, Germany.

Messrs. Fitzhugh & Spencer, who have represented the Standard Steel Works and the Baldwin Locomotive Works in Chicago, have given up the agencies. The two companies have leased a suite of rooms on the twelfth floor of the Monadnock Building, Chicago, and their offices there will be in charge of Mr. Charles Riddell.

The Brightman Furnace Company, Cleveland, has sold to the Union Pacific Railway Company three of its largest stokers. Contracts now on hand include the following Cleveland firms: Jewish Orphan Asylum (fourth order), the Cleveland Steam Fitting Company, and the B. F. Goodrich Company, Akron, O., fourth order, comprising four large stokers.

The annual meeting of the stockholders of the Westinghouse Air Brake Company of Pittsburgh was held last month. The report showed that the past year had been the most prosperous in the history of the company. The gross business was $5,947,600.57 and the profit $2,607,936.44. The old officers and directors were unanimously re-elected. The broad re-elected all of the officers.

The Wells Street bridge, Chicago, was opened to the public on the 18th, after being closed since July 3. The structure has been entirely rebuilt by the Northwestern Elevated road at an expense $25,000, being changed from a steam-powered highway to a double-decked bridge driven by electricity. The Shailer & Schnaiglau Company, Lassig Bridge and Iron Works and Vulcan Iron Works all of Chicago, were the contractors.

The American Stoker Company has recently furnished stoker equipments to the following parties: To the Pennsylvania Railroad Company, for the shops, Columbus, O. (second order); to the Davis & Egan Machine Tool Company, Cincinnati, O; to the Toledo Brewing & Malting Company, Toledo, O.; to the Michigan Carbon Works, Detroit, Mich. (second order); to the John C. Roth Packing Company, Cincinnati, O.; to the Cleveland City Water-Works, Cleveland, O.

The Murray Iron Works Company, of Burlington, Ia., bought up the business of the Sioux City Engine and Iron Works last spring, and proceeded to build new shops for the manufacture of Corliss engines at Burlington. These have now been completed and put in operation. As the old plant of the Murray Iron Works Company is well equipped for boiler construction and the building of slide-valve engines, the company is in a position to furnish complete power plants, either large or small.

The New York Dredging Company, World Building, New York has completed extensive terminal improvements for both the Norfolk & Carolina Railroad and the Southern Railroad, at Norfolk, Va. An extensive bulkhead has been constructed and the filling in behind it, with spoil, was done by the company's suction dredge Boston, the approaches to the wharves being deepened at the same time. The dredging plant has been towed to Atlantic City, N. J., to reclaim valuable areas of marsh land back of the city, by pumping upon them sand from an island belonging to the owners of the marsh land.

The city of Milwaukee has recently contracted for a new fire boat to be 107 feet long, 24 feet beam and 11 feet deep. The engines are to be double 18 inches by 20 inches with steel frames, and the screw 8 feet diameter. She will have two sets of pumps with a capacity of 6,000 gallons per minute, and an air pump and steam steering gear. This makes the third added to Milwaukee's fire department. The last built, the James Foley, at a trial test threw a four-inch stream of water 545 feet as measured by the city officials. The present boat is intended to be the finest in the world. The contractors for the machinery are the Chas. F. Elmes Engineering Works, of Chicago, who also built the two previously mentioned.

The Pedrick & Ayer Company, of Philadelphia, has recently received from the Safety Car Heating and Lighting Company an order for six Pintsch gas compressors to compress to 200 pounds per square inch. The company is also at work upon a pneumatic-hydraulic riveter gotten up by Messrs. Dodge and Caskey, of the Link Belt Engineering Company, and which they are preparing to manufacture and place on the market. The hydraulic riveting ram exerts a pressure of 40 tons, and this pressure is derived from compressed air at 80 pounds per square inch, operating on a piston large enough to give some thousands of pounds per square inch pressure in the hydraulic cylinder. The riveter is compact, and the first ones built have done good work.

For the purpose of extending the trade of the United States in the South American Republic of Venezuela, the National Association of Manufacturers, whose bureau of publicity is at 1751 North Fourth street, Philadelphia, proposes to open in the city of Caracas, the capital of Venezuela, a warehouse for the exhibition of American products of various kinds. A concession granted to the association by the Venezuelan government creates particularly favorable conditions for the establishment of such an enterprise, inasmuch as goods entered for exhibit will be admitted free of duty, the customs dues to be paid only in case of actual sale. The plans for the establishment of this permanent exhibition of American goods have reached a point where applications for space can now be received, conditioned upon the allotment of a sufficient portion of the total available space to warrant the association in inaugurating the exhibition. The aim of the association is to stimulate trade between the United States and Venezuela by familiarizing the merchants of Venezuela with the American products which they can purchase to advantage. This is the objects of the proposed exhibition warehouse. Resulting orders will go through the customary channels of trade as at present. It is estimated that an entrance fee of $100 from each exhibitor, and a charge of $1.50 per annum per square foot of space used for exhibits will yield enough to cover, or nearly cover, the running expenses of the warehouse. The minimum charge for space has been fixed at $25 per annum. This, with the entrance fee, would make the minimum charge for any exhibit $125 per annum, in addition to the cost of transportation from the United States to the warehouses in Caracas. The entrance fee and the charge for space used for exhibits constitute all the charges which will be imposed upon exhibitors by the association. Parties desiring additional information should write to the Philadelphia address given above.

Our Directory
OF OFFICIAL CHANGES IN SEPTEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlantic & Pacific.—Mr. B. Burns has been appointed Chief Engineer.

Atlantic & Pacific Railroad—Western Division.—W. H. Smith, has been appointed Purchasing Agent, with headquarters at Albuquerque, N. Mex.

Baltimore & Ohio.—Mr. Wm. Sinnott is Division Master Mechanic of the second and third divisions, with headquarters at Cumberland, Md.

Central of New Jersey.—Mr. J. G. Thomas, Assistant Superintendent of Motive Power, has been appointed Superintendent of Motive Power of the Lehigh & Susquehanna Division.

Chicago & Northwestern.—Mr. W. H. Newman has resigned the position of Third Vice-President.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. A. G. Wright has been appointed Division Master Mechanic at Altoona, Wis., vice Mr. W. E. Amann, resigned.

Great Northern.—Mr. W. W. Finley has resigned the office of Second Vice-President. He is succeeded by Mr. W. H. Newman.

Gulf, Colorado & Santa Fe.—Mr. C. W. F. Felt is Chief Engineer, with headquarters at Galveston.

Iowa Central.—Mr. Chas. W. McMeekin is Chief Engineer, with office at Marshalltown, Ia.

Kings County Elevated.—Gen. James Jourdon is Temporary Receiver.

Long Island.—Mr. W. H. Baldwin, Jr., has been elected President to succeed Mr. Austin Corbin, deceased.

Los Angeles Terminal.—Mr. William Wincup, Acting General Manager and Secretary, has resigned. Mr. S. Hynes is General Manager; Mr. F. K. Rule, Secretary, and Mr. W. J. Cox, Assistant to General Manager.

Louisville, Evansville & St. Louis.—Mr. James Gaston is appointed Master Car Builder, with headquarters at Princeton, Ind., vice Mr. W. E. Looney, resigned.

Louisville, New Albany & Chicago.—Mr. W. H. McDoel, General Manager, has been appointed Receiver.

Monterey & Mexican Gulf Railway.—E. Drageut is Superintendent of Motive Power, vice H. Nollau, previously Superintendent of Motive Power and Roadway.

New Orleans & Northwestern.—Mr. J. H. McGill has been appointed Master Mechanic in charge of locomotive machinery, water supply and car department.

New York, Philadelphia & Norfolk.—Master Mechanic C. O. Skidmore has resigned.

Norfolk & Western.—R. P. C. Sanderson, Division Superintendent of Motive Power, has resigned, and the office is abolished.

Northern Pacific.—Mr. G. W. Dickinson, General Manager of the Western lines, has resigned. Mr. W. G. Pearce, heretofore Assistant General Manager, is appointed Assistant General Superintendent, with office at Tacoma, Wash. Mr. E. H. McHenry, formerly one of the Receivers, is now Chief Engineer of the reorganized road, with office at St. Paul. Mr. W. L. Darling, formerly Chief Engineer, becomes Division Engineer, with office at St. Paul, and Mr. C. S. Bihler is Division Engineer, with office at Tacoma.

Southern.—Mr. W. W. Finley has been elected Second Vice-President, vice Mr. W. H. Baldwin, Jr., resigned. Mr. W. H. Hudson, Master Mechanic at Atlanta, has been transferred to Salisbury, N. C. Mr. W. L. Tracey is transferred from Birmingham to Atlanta, and Mr. W. A. Stone, Master Mechanic at Selma, Ala., is appointed to the position at Birmingham.

Employment.

A mechanical draughtsman, having 16 years' experience in car construction, is desirous of a position as assistant to General Foreman, Inspector of New Equipment, or Draughtsman. Will give best of references. Address, care of this paper.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

NOVEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

V.

(*Continued from page* 245.)

In the last article on the Altoona shops the principal features of the Gölsdorf and Von Borries compound engines, with which the Pennsylvania Company is experimenting, were illustrated and described. It remains to explain the construction of the other two engines.

THE "PITTSBURGH" SYSTEM.

The general features of construction of this engine are shown by Fig. 1. Figs. 2 and 3 are sectional views of the intercepting valve, which is located between the cylinders. In Fig. 2 the valve is shown in the position it occupies when the engine is working simple. Steam from the boiler can then enter the steam-chest of the high-pressure cylinder through the passage *N* and to the receiver and low-pressure cylinder by the passage *K*. When the parts are in the position shown the steam in *K* moves the reducing-valve *C* from its seat and thus allows steam to flow from *K* into the passages *O* and *P*, as indicated by the darts, and thence to the receiver and low-pressure cylinder. When the intercepting valve *A* is in the position shown, the passage *Q*, which communicates with the exhaust of the high-pressure cylinder, is connected with *M*, which leads to the atmosphere. The high-pressure cylinder thus exhausts directly into the chimney and the low-pressure cylinder is supplied with live steam from the passage *K*.

To change the engine so as to work compound a cylinder *E*, Fig. 1, is placed on the position shown. This cylinder has a piston which is connected by a rod *F* to a double-armed lever *G*, the lower end of which is connected to the intercepting valve stem *H*. Inside of the cab a double-armed L-shaped lever *D* is provided, the horizontal arm of which has a slot in which a pin on the reverse lever works. This slot has depressions at each end so that when the reverse lever is at its extreme throw in either direction the horizontal arm of the lever *D* will be raised up by a spring *S* at its back end.

The upper end of the vertical arm of this lever is connected to a valve on the cylinder *E*. The throttle lever being open when the reverse lever is thrown backward from its extreme forward position, it acts on the lever *D*, and moves the valve in the cylinder *E*, so as to admit steam to its front end and exhaust it from the back end, thus forcing the piston backward and causing the intercepting valve *A*, Fig. 2, to move forward into the position shown in Fig. 3. This movement first closes communication from the high-pressure cylinder exhaust passage *Q*, and the passage *M*, which leads to the chimney and opens communication from *Q* to the passages *P*, which leads to the receiver and low-pressure cylinder. The steam from the high-pressure cylinder instead of exhausting up the chimney is thus discharged into the receiver and low-pressure cylinder. The movement of the valve *A* causes the piston *B* to come in contact with the valve *C* and thus closes it and shuts off steam from the passage *K*. The engine then works compound.

THE "RICHMOND" SYSTEM.

Figs. 4, 5 and 6 illustrate the chief features of construction of the "Richmond" system. They are similar to the views of the Pittsburgh engine. To work the Richmond engine simple, the

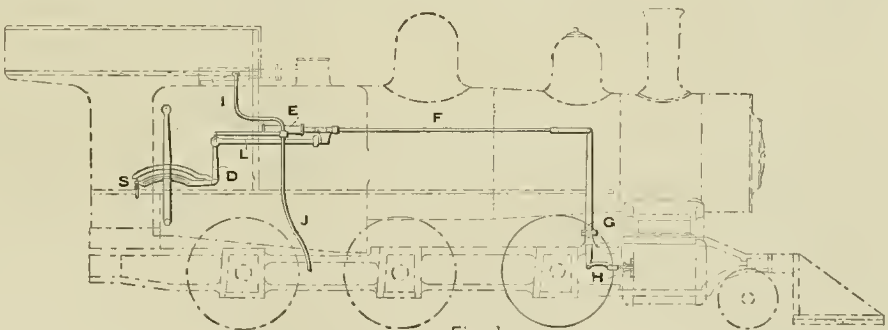


Fig. 1

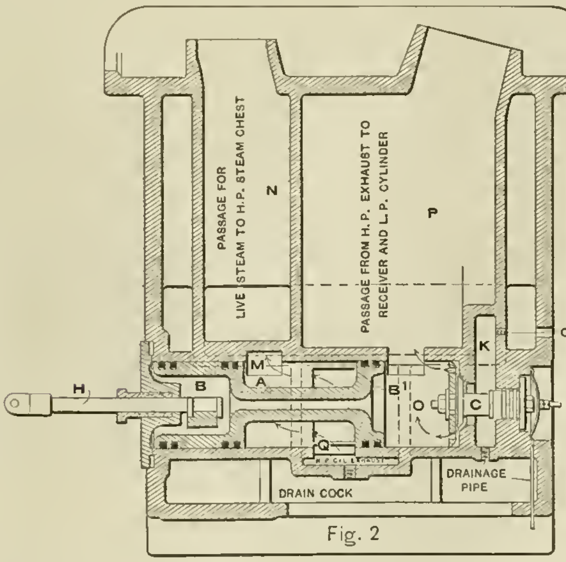


Fig. 2

POSITION OF VALVE WHEN ENGINE IS WORKING SIMPLE

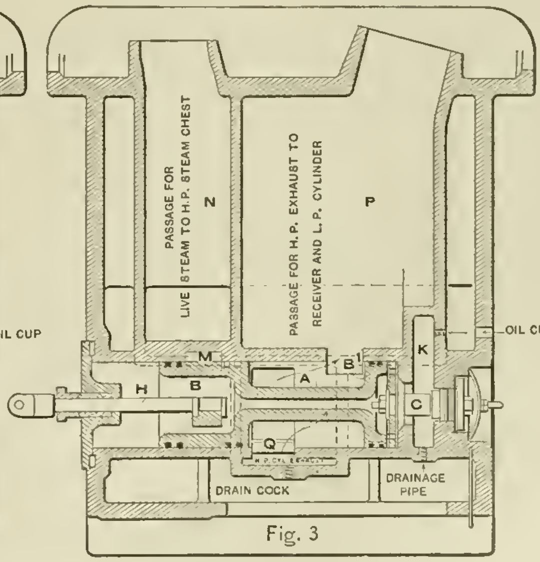


Fig. 3

POSITION OF VALVE WHEN ENGINE IS WORKING COMPOUND

Pittsburg System as applied to a Mogul Locomotive by the Pennsylvania Railroad.

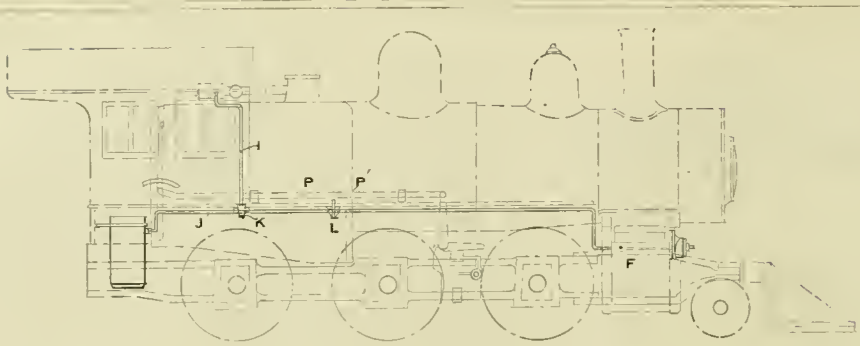


Fig. 4

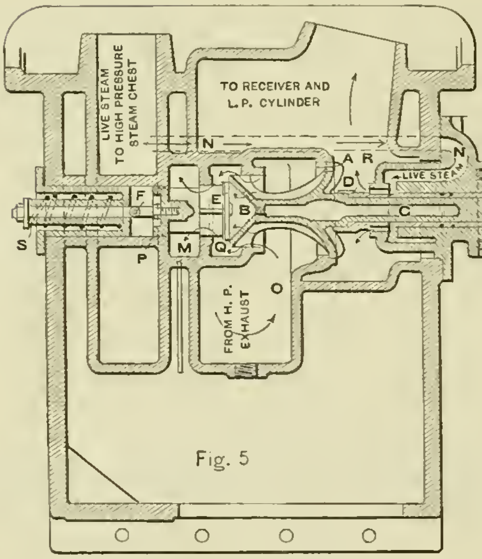


Fig. 5

POSITION OF VALVE WHEN ENGINE IS WORKING SIMPLE

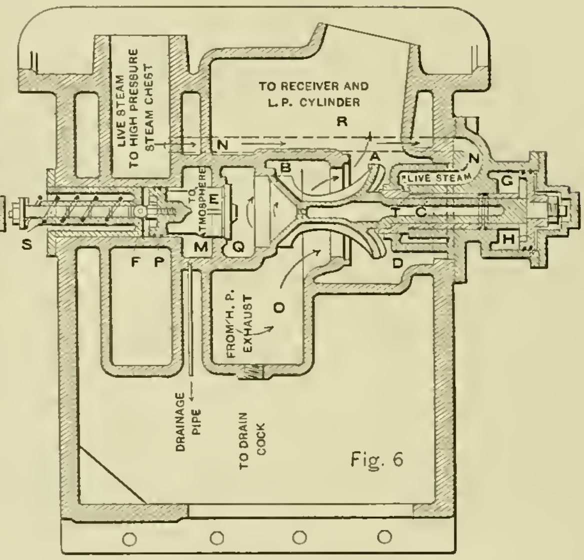


Fig. 6

POSITION OF VALVE WHEN ENGINE IS WORKING COMPOUND

The Richmond System as applied to a Compound Mogul Locomotive by the Pennsylvania Railroad.

throttle valve is opened and the reverse-lever thrown either full gear forward or full gear back. When this is done one of two tappets *P*, P^1 Fig. 4, on the reverse rod engage with the lever of the operating valve *L*, which admits compressed air or steam by a pipe to the chamber *F*, indicated in Fig. 4 and shown clearly in Fig. 5. The pressure of the air or steam acts on the piston *P*. Fig. 5, attached to the emergency valve *E* moving them forward and opening communication between the chambers *M* and *Q*. As *M* communicates with the atmosphere, this movement allows the steam in *M* and *Q* to escape, and thus relieves the pressure in the chamber *Q* back of the piston *B* attached to the intercepting valve *A*. At the same time steam which passes through the passage *N* opens the admission and reducing valve *D* and allows steam to flow into the space *R*, which leads to the receiver and low-pressure cylinder, and closes the intercepting valve *A* and opens *B*. The exhaust can now escape direct from the exhaust passage *O* of the high-pressure cylinder to *Q* and *M*, and thence to the atmosphere, and the low-pressure cylinder is at the same time supplied with live steam which enters the receiver through the pipe *N*.

To change to compound working, the throttle being opened, the reverse lever is withdrawn from its full forward or back positions which disengages the tappet *P* or P^1, and the lever of the operating valve *L*, Fig. 4, cutting off the steam or air supply to the cavity *F*, Fig. 5, which allows the action of the helical spring *S* to close the valve *E*, as shown in Fig. 6. At the same time the exhaust steam from the high-pressure cylinder accumulating in the cavity *O*, this pressure soon exceeds that in the opposite side of the intercepting valve *A*. It is forced from its seat and at the same time closes *D*, and thus shuts off the supply of live steam to the low-pressure cylinder through the passage *N*, and opens communications between the passage *O*, or from the exhaust of the high-pressure cylinder to *R*, and to the receiver and low-pressure cylinder, so that the latter then gets its supply of steam from the receiver, and the exhaust of the other cylinder, thus changing the working of the engine from simple to compound.

The sleeve of the valve *D* has an axial movement on the stem *C* of the intercepting valve and by reason of the difference of area of the end of the sleeve and the shoulder cap *T*, the sleeve acts as an admission and reducing valve to the low-pressure cylinder, when starting and when working simple and equalizes the pressure in the two cylinders.

The function of the valve *B* is to insure a quick closing of the valve *A* when *E* is opened.

The tests of the experimental compound engine in the Pennsylvania road are now completed, and have shown a decided advantage for the compound system, but the data and conclusions drawn from these tests have not yet been made public.

CLASS L PASSENGER LOCOMOTIVE.

Reference has been made several times in these articles to what is known as the class L passenger locomotives. These are built from the most recent designs which have been evolved on the mechanical department of the Pennsylvania Railroad. The accompanying engravings show some interesting features in the construction of these engines. Among these are the guides and cross-heads which were designed, and have been patented by Mr. Vogt, the mechanical engineer. Their external appearance is shown in the perspective view of the engine and the details of construction of the guides by Fig 8.

These are made of cast-iron and are of box shape, the form of which is shown clearly by the transverse section. They are joined together on the vertical center-line and bolted by transverse bolts as shown. Strong ribs on the back give vertical stiffness, and their form gives all the horizontal rigidity required. The cross-head is shown in the same figure and is made of cast

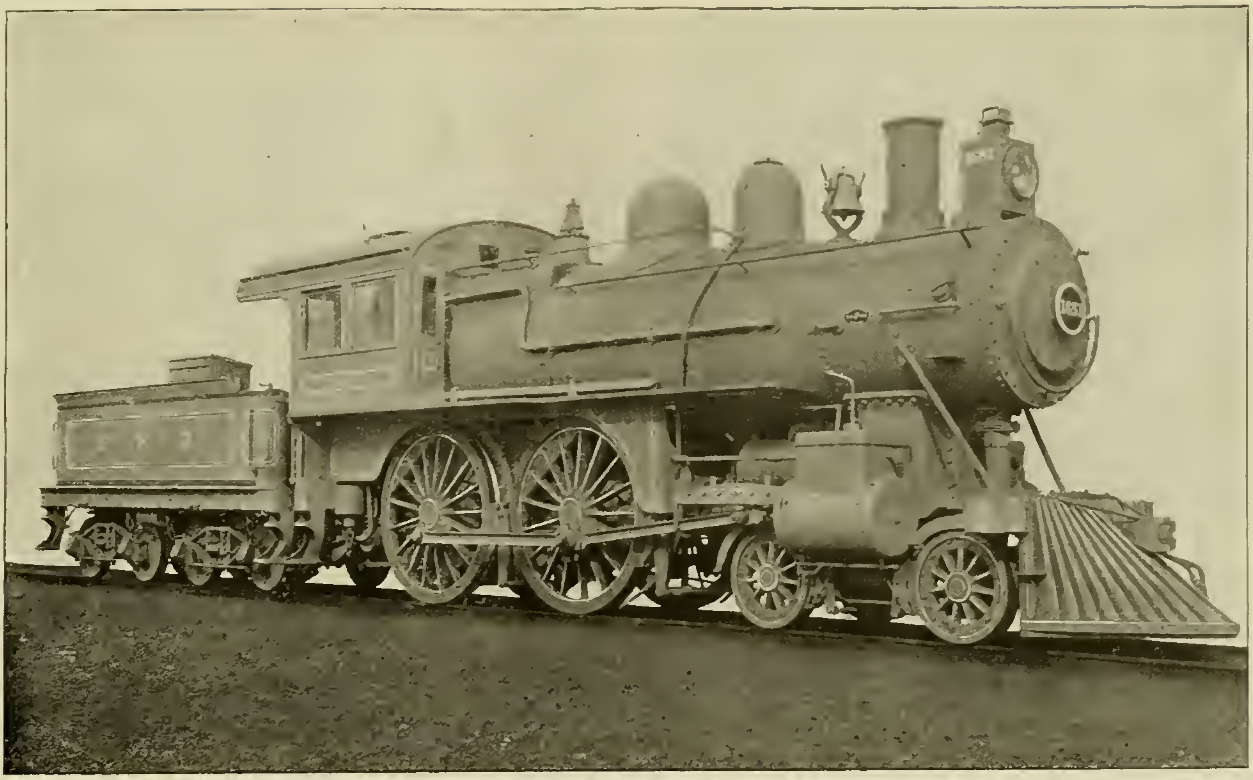


Fig. 7.—Class L Passenger Engine, Pennsylvania Railroad.
F. D. CASANAVE, Genl. Supt. Motive Power. A. S. VOGT, Mechanical Engineer.

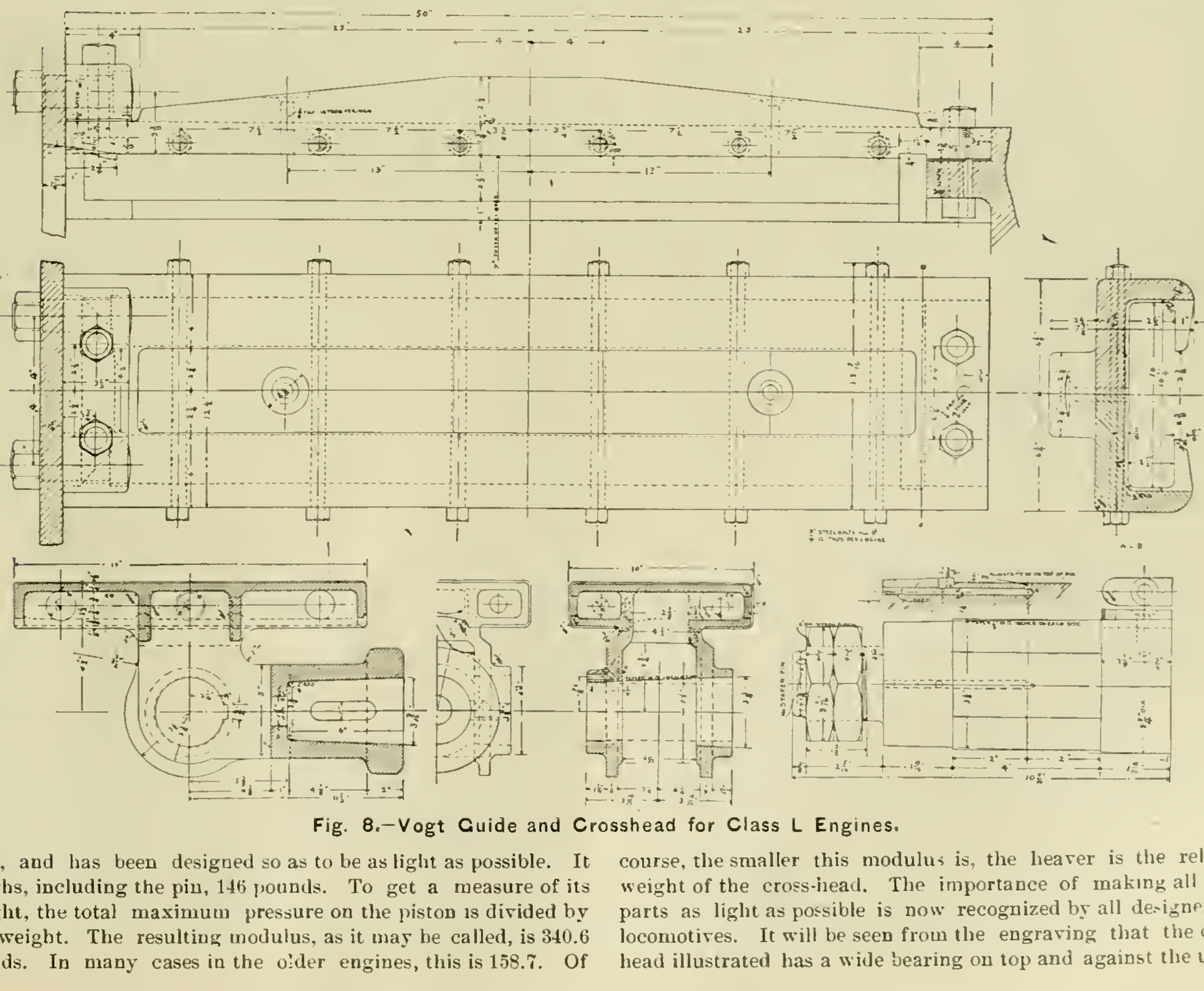


Fig. 8.—Vogt Guide and Crosshead for Class L Engines.

steel, and has been designed so as to be as light as possible. It weighs, including the pin, 146 pounds. To get a measure of its weight, the total maximum pressure on the piston is divided by this weight. The resulting modulus, as it may be called, is 340.6 pounds. In many cases in the older engines, this is 158.7. Of course, the smaller this modulus is, the heaver is the relative weight of the cross-head. The importance of making all these parts as light as possible is now recognized by all designers of locomotives. It will be seen from the engraving that the cross-head illustrated has a wide bearing on top and against the under

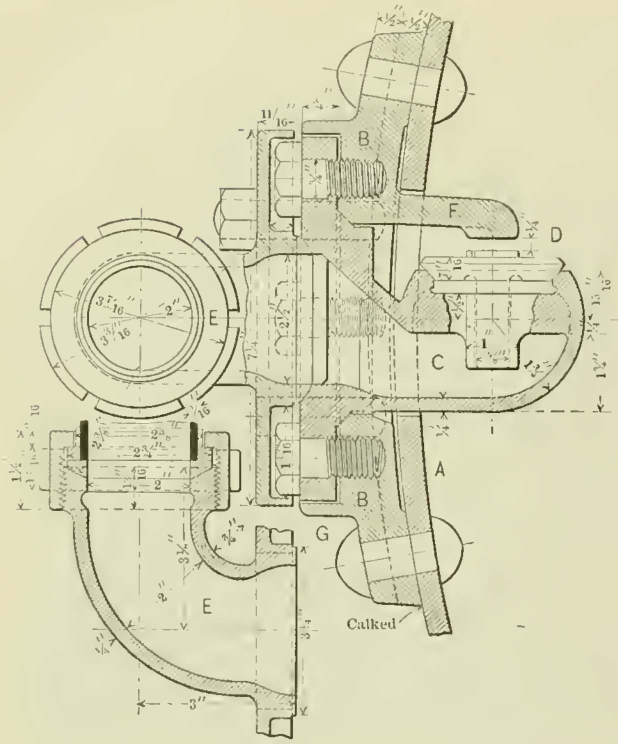


Fig. 9.

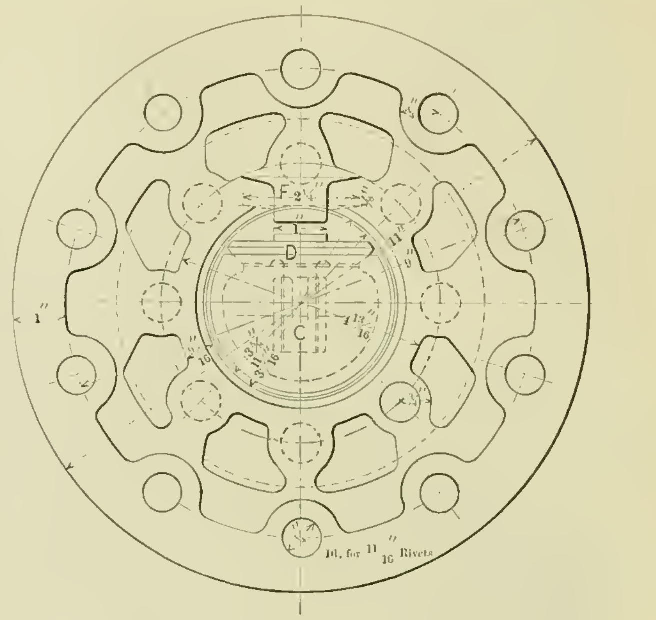


Fig. 10.

Wright's Safety Boiler Check.

side of the wearing surface of the guides. In running forward, the pressure is always upward on this wide bearing. All of the sliding surfaces of the guide are covered with tin ⅛ inch thick The steel slides are first planed, and the tin when melted adheres, to the steel. A sufficient thickness of tin is cast on the slides to permit of their being planed to the proper dimensions. As shown in the perspective view, the design is a very neat one, and it has worked very satisfactorily.

The pistons used in these engines have heads made of cast steel. To the outside of this a cast-iron piston ring is bolted. This has grooves turned in it to receive the cast-iron packing rings. In the under portion of the piston a segmented piece of an ˥-shaped sectional form is fitted so as to cover the joints of the packing rings. It also serves the purpose of preventing the packing rings from turning in the piston ring. The latter is widened out on its under side in order to give a greater bearing on the bottom of the cylinder. This permits the upper portions and the sides of the rings to be made narrower. By this means the stroke of the pistons has been increased from 24 to 26 inches without lengthening the cylinders. The cylinder heads are made to conform to the shape of the piston heads, and suitable cavities are made in the heads to receive the wide bearing of the piston ring.

SAFETY BOILER CHECK-VALVE.

It may be remembered by some of our readers who are no longer young that, some 10 or 15 years ago, a serious accident occurred on the Pennsylvania Railroad near Pittsburgh. A local train was standing at a station and a following express train ran into the rear end of the former. The locomotive "telescoped" into the last car of the local train, and in doing so one of the check-valve cases was knocked off and the hot water and steam in the boiler was discharged into the car filled with passengers. Many of them were killed or frightfully scalded. This accident led to the adoption of a check valve located inside of the boiler, so that in case of collision it would not be injured.

The first form which was extensively used consisted of a flap-valve, an engraving of which is published on page 219 of the revised edition of the "Catechism of the Locomotive." Experience showed that this form of valve was open to some objections, which led to the design illustrated herewith. This was made, and has been patented, by Mr. William Wright, chief draftsman in the machinery department at Altoona, and is now used on all new engines, and has been made standard by the Pennsylnania Railroad Company, as well as the Southern Railway Company.

Fig. 9 gives a sectional view of the valve, and its seat drawn in a plane transversely to the boiler, and Fig. 10 is a side view looking at the valve from the inside of the boiler; also in the lower left-hand corner of Fig. 9 is a sectional plan of the pipe connection. *AA* represents a portion of the boiler plate. *BB* is a brass flange riveted to the boiler plate and calked on the edges. It has a circular central opening to receive the valve-seat or casing *C*. This, as shown in the engraving, has a flange outside, which is bolted to the riveted plate, and a valve-seat inside the boiler provided with a mushroom valve, which acts vertically, thus allowing the water to enter the boiler at the valve-seat, and all around its periphery. The stream of water thus washes the seat and has the effect of removing any obstructions which might otherwise lodge between the valve and its seat. It should be understood that injectors all have check-valves of their own, and therefore there is the same pressure above and below the boiler-check, and, consequently, when the injector is shut off, the boiler check-valve is not seated by the pressure above, as is generally supposed, but by gravity alone. Owing to this cause the old hinged flap-valve often becomes inoperative by the deposition of sediment or incrustation on the hinge.

It will be seen from the the engraving that the riveted plate *B* has a projection or finger *F* which projects into the boiler and over the top of the valve, and which acts as a stop to its upward movement or "lift."

The valve-casing *C* is securely fastened to the riveted plate *B* by four bolts and a flange which is protected by a circular guard or flange *GG*. The elbow *E* to which the feed-pipe is attached is fastened to the riveted flange by four studs. The valve and its seat, which would be the source of danger if broken off in a collision or other accident, is thus very securely fastened to the boiler, is all under the jacket, and as close to the boiler as possible, the only projecting portion being the pipe elbow, which is made very light at its juncture with the flanges, so that if it is broken it will not at the same time break any of the parts to which it is attached.

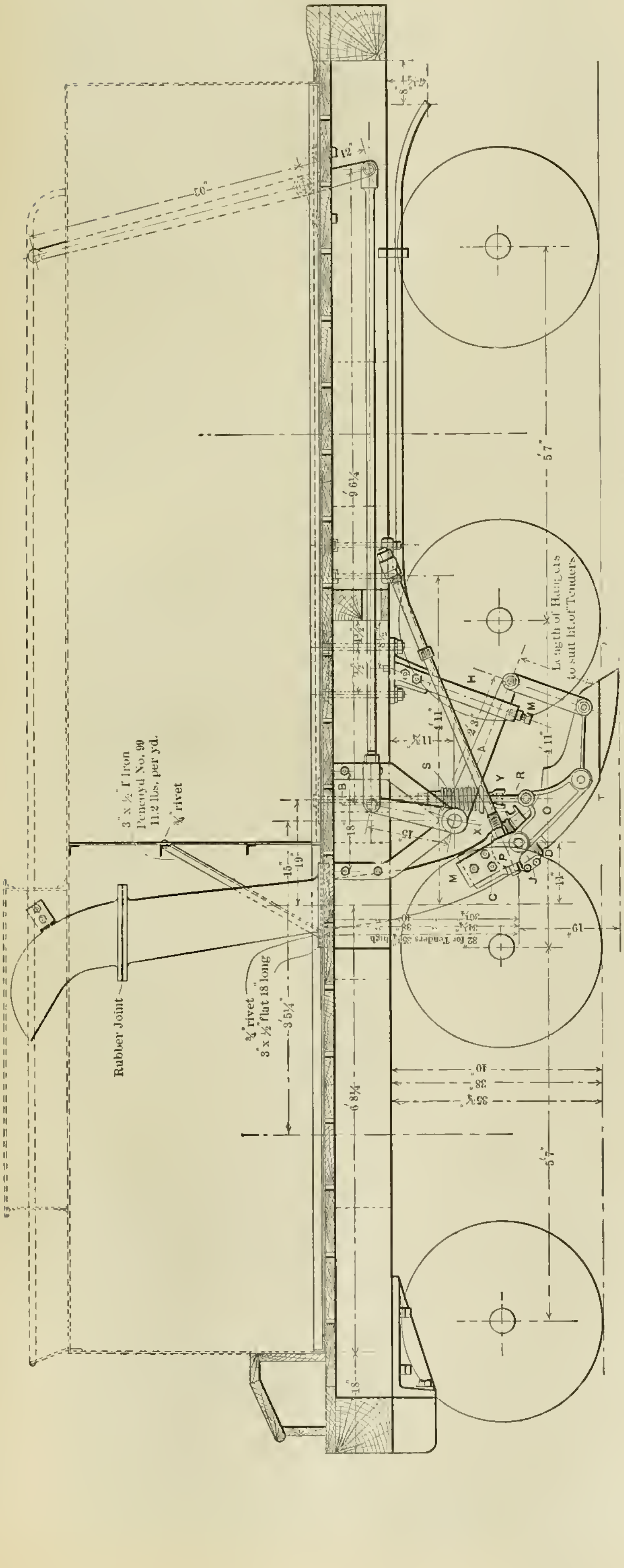


Fig. 11.—Kiesel's Balanced Tender Scoop.

The flange on the elbow projects partly into the jacket, to make a good finish, and on being removed the valve-casing can be taken out through the opening in the jacket and that in the riveted plate. Neither the jacket nor any other parts need be disturbed to take out the check valve, which can thus be readily cleaned as required.

All the parts excepting the studs, bolts and nuts are made of brass, and as light as is consistent with the required strength.

These checks have been applied to about 200 locomotives so far, and, it is said, have given entire satisfaction. In view of the terrible accidents which may occur from the breaking off of an ordinary check valve, the use of some such device as this should be made compulsory on railroads, and such a simple appliance being available, railroad managers incur a grave responsibility if they do not use it.

BALANCED TENDER SCOOP.

Tender scoops, in use heretofore, although answering the purpose for which they were intended primarily, still had one objectionable feature which became more and more apparent with the increased speed of the past few years. This defect consists of the necessity of slowing down to take water from the track trough, thus causing loss of time; also, it was necessary that a definite speed be reached; for, if the speed was too slow, it became necessary to hold down the dipper by means of the operating lever and, if too fast, the dipper could scarcely be raised, even though both engineer and fireman exerted all their strength to do so. Twenty-five miles per hour is about the greatest speed at which such scoops could be raised from the trough, and then if the dipper did not yield at the first pull, it would be dragged over the end of the trough and the mouth of the dipper was thus liable to be crushed. In consequence, it was necessary to constantly repair or replace the dippers.

The tender scoop illustrated by Figs. 11 and 12, on which letters patent have been granted to W. F. Kiesel, Jr., connected with the Mechanical Engineer's office, at Altoona, Pa., was designed to overcome this objection, the aim being to make it as efficient and easily operated at the greatest attainable speed as when running slowly.

The dipper proper, that is the portion extending from *D* to *E*, Fig. 11, is carried on pivoted supports or bolts *T*. The upper part of the dipper is connected to the up-take pipe *M* by an intermediate section *J*, which is supported on the pivots *P*. It is connected to the uptake pipe *M* by a semi-circular joint which is indicated by a dotted line. The short section can therefore turn about the pivot *P*, and can move in contact with the pipe *M*. The junction of the dipper with *J* is of a segmental form drawn from *T* as a center. The dipper can therefore turn about the pivot *T*, and can move in contact with *J* on the segmental joint. It will thus be seen that the dipper is balanced on the pivots *T* attached to brackets *O*, which are cast on and form a part of the intermediate section *J*.

The top of the dipper is open to a point immediately above the pivots *T*, so that any spray or wave may be carried up with the larger body of water.

The intermediate joint *J* of conduit is pivoted at *P*, and is held by cheek pieces *C*. The cradle itself is attached to two rods *RR*, passing through two light spiral springs *SS*, which are compressed when the dipper is lowered. These springs are set on a yoke *Y*, fixed to the frame of the tender by means of bolts *BB*, and serve only as a balance for the weight of the dipper and other movable parts when the dipper is not in use, so that, if anything should give way, or a pin be lost, the dipper would not drop to the track and possibly cause damage.

The nuts *NN* at the top of the springs project partly inside of the coils and form a definite stop and also a convenient mode of adjusting the position of the mouth of the dipper.

The hanger *H* with adjustable set screw *M* is simply a safeguard against any springing of the tender frame or arm *A*, which would result in lowering the mouth of the dipper in the trough, and a possibility of scraping along the bottom.

When water is flowing into the tender, it exerts a certain pressure on the dipper, which increases with the speed of the engine.

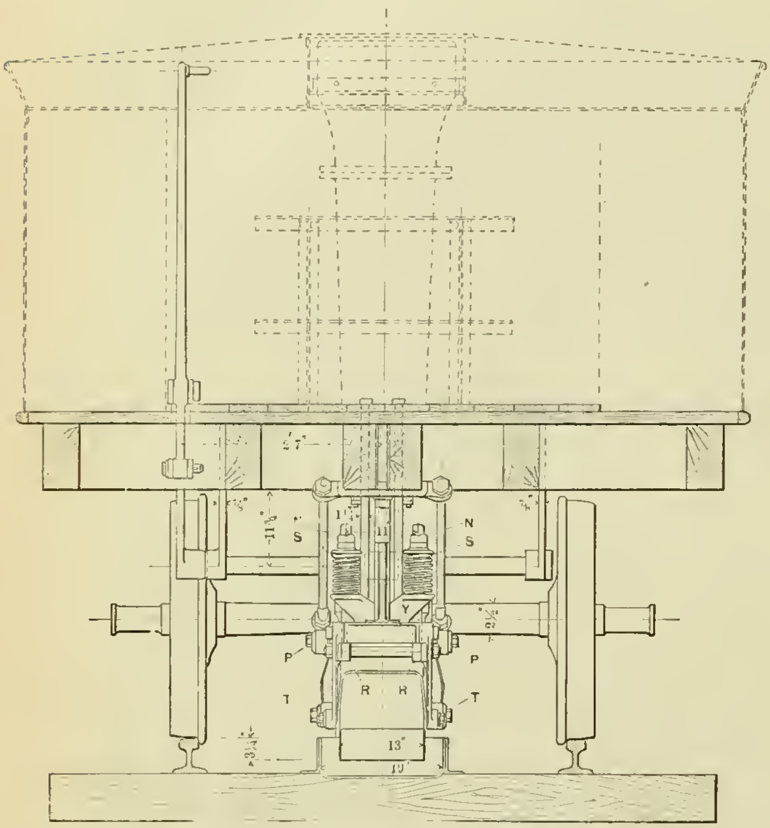


Fig. 12.—Kiesel's Balanced Tender Scoop.

Therefore the dipper is pivoted near its center, so that the pressure in the upper half balances that in the lower half. This makes it entirely independent of speed.

In lowering the dipper the only resistance is that due to the springs *S S*. In raising it out of the water the pressure on the trunnions *T* holds down the cradle and the dipper moves round the trunnions *T* until the stops *X X* touch the arms of the cradle. This gives enough motion to the dipper to allow the mouth to rise clear of the water, consequently no more water rushes in and the rest of the movement takes place easily around the pivot *P*.

Lowering and raising can be easily accomplished with one hand at any speed.

The first scoop built was in continual service for eighteen months without costing anything for repairs. For the past two years the Pennsylvania Railroad Company has been equipping all new tenders with this scoop, and there are now more than seventy-five in service. They are giving excellent satisfaction and are very much liked by the engineers, who claim that they can fill their tenders in much less distance than with the old scoop, and besides this they are not obliged to slow down to take water as was the case formerly. They can therefore more easily make up lost time.

Before adopting this scoop, the Pennsylvania Railroad Co gave it a thorough trial, and found that it proved superior in all respects to anything in that line before used. It has also been proved that with this scoop less water is wasted by being sprayed or thrown out of troughs, that the cost of repairs has been materially decreased and more water per hundred feet run is delivered into the tank. Running at 70 miles per hour a 3,000-gallon tender was filled on a trough 1,000 ft. long in nine seconds.

Before these scoops were adopted it almost became necessary to either increase the length of troughs or use more of them, because it was nearly impossible to fill the tanks with the old scoops when used in connection with the larger locomotives. Now there is no difficulty in this respect, even when running double-header engines. The Pennsylvania Railroad Co. is also equipping their new mogul fast freight engines with this balanced scoop in order to be able to run through without stopping or even slowing up to take water.

FIREBOX.

From the perspective view it will be noticed that the sides of the firebox are of a somewhat peculiar form. The back part of the waist of the boiler where it joins the firebox is of large diameter, and it was desirable to make the front of the firebox conform to the contour of this part of the waist where they join each other. If the width of the firebox had been made equal to the largest diameter of the waist it would have contracted the space very much between the sides of the firebox and cab. Consequently the front portion of the firebox steel was swelled out to the diameter of the shell, and the swell was carried by a diminishing taper from the front to the back. The tip or Belpaire part of the firebox shell it will be seen is made of less width than the diameter of the waist, which gives more room for outlook between it and the cab.

VALVE GEAR.

The maximum throw of the valves of these engines is six inches, the throw of the eccentrics being $5\frac{1}{4}$, the difference being due to the effect of unequal length of rocker arms. The valves have $1\frac{1}{8}$ inches lap. $\frac{1}{16}$ inch lead when working full stroke in the forward motion and $\frac{3}{32}$ inch lead in the backwark motion. The valves have $\frac{1}{16}$ inch inside clearance in the front steam port and $\frac{1}{4}$ inch on the back one. The unequal clearance is given in order to equalize the points of release, and thus make the engines exhaust "square," as it is termed in roundhouse vernacular.

Another feature of the construction which may be commended in those engines is the admirable arrangement of steps and handholds which are provided for the men. Commencing from the front of the engine, it will be seen that a step is attached to the side of the pilot about half way between the bottom and the top, and a semi-circular hand-rail is attached to the lower portion of the smokebox front. Another step is placed to the side of the smokebox, with a short hand rail above it, and on a horizontal line with the center of the smokebox. The usual hand-rail is provided at the top of the boiler, and extends to the front of the smokebox. At the back end of the engine two steps of liberal size are provided, which are held in suitable box-shaped guards. Similar steps are attached to the front and back end of the tender. Over each pair of these steps long vertical handholds are placed, which are within convenient reach from the ground. The step at the back end of the tender is a new feature, and a very excellent one. With all the care that can be taken, and with all the appliances which can be provided, the occupations of locomotive engineers and firemen are still frightfully dangerous, and there is no excuse for omitting such comparatively inexpensive attachments as have been described. Nevertheless they very often are omitted, or are wretchedly inadequate for the purposes for which they are intended. Such omission or neglect is criminal, and ought to be punishable in some way.

(*To be Continued.*)

The New Heilmann Electric Locomotive.

The *Revue Internationale de l'Electrite* is unsparing in its criticisms of the new Heilmann locomotive. From a recent article translated by the *Electrical Review*, we take the following: The Heilmann locomotive, which was tried in 1893 on the Western Railway of France, has now been constructed or is now re-constructing, of a size to develop 1 350 horse-power. Improvements suggested are better suspension of the motors, a new type of steam engine, and modified driver's apparatus. The boiler is to be of ordinary locomotive type. The heating surface will be 180 square metres (1,937.5 square feet), and the grate surface 3.3 square metres, or about 35 feet—a pretty large area for a European locomotive. The engine is to be a Williams and Robinson, with six cranks. The Heilman scheme simply brings electrical working into contempt, for it cannot prove an economy. It carries an immense boiler and a six-crank steam engine, and its one advantage is that in going uphill the steam engine can be run at speed, and will not therefore lose power, as is now the case with a locomotive, which as it travels slower, also revolves slower, and loses power thereby. But this is to some extent a fable. When a locomotive mounts a hill it revolves more slowly, and, therefore, gets more pressure, and for an occasional hill it is not usually necessary to take along the whole roundhouse. However, our readers may judge for themselves. The two generators, of a pressure of 450 volts, are excited by a dynamo, driven by its own 28 horse-power engine, the motors are fixed to the frame of the bogies, and have an elastic connection with the axles. The power is 1,000 horse power at the rail. The drawbar pull is a little under half the cylinder output. The tyre pull is about 75 per cent. of the cylinder indication, so that: of 1,000 horse power, 250 is lost in the transmission and 250 in the engine considered as a carriage, and the new engines are to be capable of hauling 350 tons at a speed of 100 kilometers about 80 miles). It is thought that at present the advantage as to coal consumption rests with the ordinary locomotive The first Heilmann engine weighed 115 to 120 tons, and only developed 450 horse power, but the new machines are to develop 1,000 at the rail, and apparently only weigh 120 tons, or at the rate of 100 kilograms per horse power, as compared with the weight of torpedo boat machinery only 16 kilograms per horse power, a comparison of little moment, however, considering the difference of conditions It is expected that these new moving stations will be ready for trial at an early date. We do not doubt that the locomotive will run; that it will do so at a high speed; that it will haul good loads; that it will be a hill climber. We may admit all this, and more; and we think we shall still be free to paraphrase a famous French saying and repeat, "It is magnificent, but it is not engineering."

The Bates Thermic Engine.

For a year or more brief notices have appeared of a new gas motor that was to do wonders, but an air of mystery surrounded it, until a few weeks ago, when a 100 horse-power engine was put on exhibition in Philadelphia. This engine, known as the Bates Thermic engine, is of the vertical type, and has two single-acting cylinders 15.75 inches in diameter and 15.75 inches stroke, and has been run at various speeds up to nearly 200 revolutions per minute.

The cylinders are in three sections, one above the other. The lower one is the barrel, in which the piston and its packing slides; this is kept cool by a water jacket. The section immediately above this is the space in which the gas is burned, expanded and made to perform its work on the piston. The water from the jacket of the lower section rises into the jacket of this one and controls its temperature. The circulation of water is so slow, however, that it turns to steam before it leaves the jacket of the third section, in which the admission and exhaust valves are placed, and which forms what might be called a valve chest.

The exhaust gases from the cylinders pass into two regenerators, which take the place of one side of the A frames which usually support the cylinders of a vertical engine. In these regenerators the exhaust parts with a portion of its heat to compressed air forced through it by a horizontal compressor driven from the crank shaft. Part of this compressed air is used in the combustion of the gas in the engine cylinders, while the remainder of it goes to a gas producer standing behind the engine. Here it is joined by the steam generated in the jackets of the engine cylinders and passes up through the fuel, making a kind of producer gas, called "Gardie" gas after the inventer. The gas is generated under a pressure of about 70 pounds and is led through a "dust separator" to the throttle valve of the engine, from whence it goes to the cylinders.

Each cylinder has three valves in the top head, one for gas, one for air and the third for the exhaust. These three valves are all of the poppet type and are operated by cams on a horizontal shaft extending across the tops of the two cylinders and driven by bevel gearing and a vertical shaft, which in turn is driven by the main shaft. The governor, acting on the admission valves only, is of the ball type and is said to give perfect regulation. The variation in speed is very perceptible, however. It should be said that the gas is not exploded in the cylinder but burns as it enters until the admission valves close, when it expands as in the steam engine. The indicator card thus resembles those taken from a steam engine, rather than the ordinary gas-engine cards. The initial pressure is under 100 pounds.

From this brief description it will be seen that this engine is simply a gas engine fitted with a regenerator and a gas-producer. There is nothing mysterious about it and its advantage over other gas engines, if it proves to have any, will be in the fact that a part of heat lost in the jacket and exhaust of other gas engines, is utilized in this one. This is certainly a desirable object to attain. The resulting economy in this case has not been great, however, as the coal consumption under test is about 1.2 pounds of coal per horse-power per hour, a figure which has been beaten by well-designed gas engines of the common Otto-cycle.

As already stated, the main shaft drives an air-compressor for furnishing air to the gas-producer and the main cylinder. A small water pump is also driven from the main shaft to supply water to the cylinder jackets. In order to start the engine after it has become cold, a steam boiler and an independent air-compressor must be employed to furnish steam and air, until the producer is in running condition, or for say nearly one hour for a 100 horse-power engine. A very small dynamo is also needed to heat two thin plates in each cylinder, which are employed to ignite the gases, but which keep hot enough for that purpose without an electric current once the engine is started.

It will thus be seen that a rather formidable array of machinery is needed, and it is not clear where the saving is to come in over a good gas engine with an independent gas producer, in the operation of which the heat of the jacket and exhaust is in some measure saved by regeneration in one form or other. In fact this type of engine is somewhat handicapped by the fact that everything is under pressure, even the production of gas, and the air needed for this process must be compressed to 70 pounds pressure. The net output of this particular engine is 100 horse-power but it generates about 140 horse-power, of which 40 horse-power is used by the compressor.

Communications.

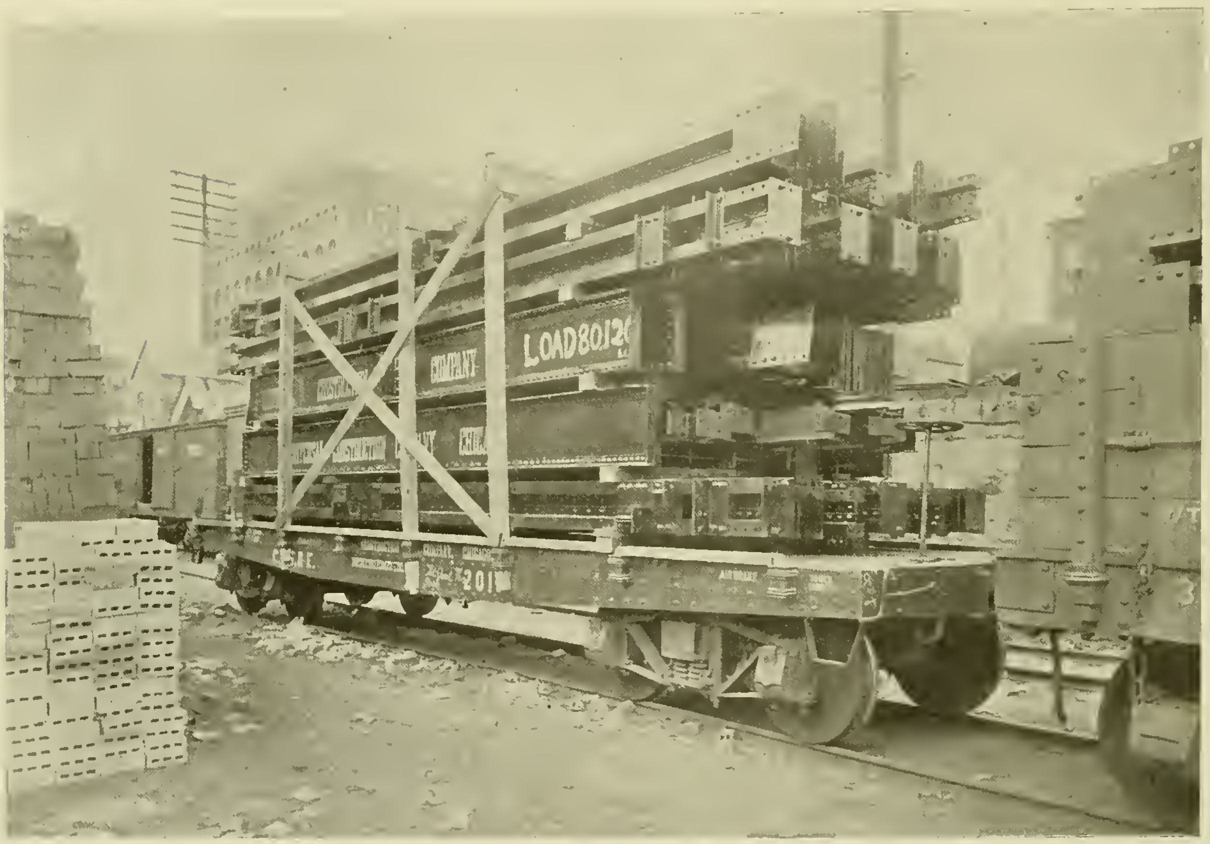
Metal Cars in France.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Mr. Tolmer's article on the results of from twenty to thirty years' experience with metal under-frames for cars on the Eastern Railroad of France, published in your August issue, is of great interest and value to American railroad men.

The writer has recently had occasion to examine metal under-frames of a number of locomotive tenders formed principally of heavy angle iron, and which had been in service from five to eleven years. Even in this comparatively short period the angle irons forming the sills and crossties were very badly rusted, many of them fully as bad as the section shown in Mr. Tolmer's article from cars that had been in service over twice this length of time. It was found also that the corrosion occurred almost entirely in those portions of the sills which are exposed and not covered by attaching other members of the frame to them. At these points comparatively little corrosion had taken place. The cause of this condition was, of course, due to the exposed parts not being kept covered with paint. Had they been kept thoroughly painted, I have no doubt they would still be in almost their original condition. The very excellent results obtained from metal under-frames on the Eastern Railway of France is undoubtedly due to their being carefully protected by paint, which is renewed at sufficiently frequent intervals to keep the surface well covered. There is no doubt that there are many places in metal under-frames that are difficult to reach with a paint brush, but there seems no reason why this should be neglected if the now well-known device for applying paint with a spray formed by compressed air, flowing through a suitable nozzle, is used. There is no doubt the thorough protection of metal under-framing by liberal use of paint well maintained is an important matter and too often neglected in American railroad practice. E. M. H.

Mr. W. B. Greenlee, in the *American Geologist*, estimates that the volume of water absorbed in the earth's crust to a depth of one mile, and over the entire land area of the globe, is 8,498,000 cubic miles.



Universal Construction Company's Steel Car Loaded With 40 Tons of Structural Steel.

A Heavily Loaded Flat Car.

On Sept. 22, 1896, on train No. 583, of the Chicago & Northwestern Railway, leaving Chicago at 8:45 p. m., there was taken to St. Paul car No. 201, built by the Universal Construction Company entirely of steel and loaded with 80,120 pounds of structural steel for the Northern Pacific Office Building, for which the Universal Construction Company has the contract. The accompanying cut, from a photograph taken at St. Paul, shows the size of the load and the method of securing it. Careful inspection on arrival showed that the car and its freight had traveled in perfect safety and good order, and as the train referred to is a fast merchandise train and arrived at 2 a. m. on the 24th, showing that only 27¼ hours were taken in transit, it is evident that this large and unique load did not in any way interfere with the usual rapid movement of this train. It speaks well for the construction of the car and trucks and the disposition of the 40 tons of material placed thereon.

The Universal Construction Company is continuing its experiments and its development of the metal car. It is just completing the construction of a modified form of flat car built on the Pennock plan, but somewhat simplified. It is also operating gondola cars in the coal business, carrying from 68,000 to 75,000 pounds at a trip, while its ore cars (one of which was exhibited at Saratoga), are carrying from 78,000 to 89,000 pounds at a trip. No weakness or defect has developed up to the present time in any of these cars, and the company is so well pleased with the result of its experiments, that it is bringing out further designs for refrigerator, stock and hopper cars. It has recently received inquiries from South America for equipment built on these lines.

The Cleveland, Cincinnati, Chicago & St. Louis Railway Company has abandoned the use of dummy couplers for hanging up air hose on its freight cars, and these cars will be accepted in interchange without the dummy couplings. Bills for repairs or replacement of same will not be accepted.

Water-Tube Boilers on French War Ships.

A Paris correspondent of the *Steamship*, writing on the subject of water-tube boilers in the French Navy, says: "The question of the tubular boilers, which Mr. Allan repeatedly raised in the House of Commons last session has sprung up here in consequence of the partial disablement necessitating the detention of two ironclads at Brest. These vessels, the *Bouvines* and the *Amiral-Trehouart*, form part of the northern squadron. They put into Brest last week, on arriving from St. Malo, and an examination of their boilers revealed defects in a certain number of the tubes. The latter needed to be replaced 'to avoid accidents similar to those which recently occured on board the *Jaureguiberry*.' After Mr. Allan's unwearied denunciations of the Belleville turbular boiler—one of his grounds for attack being that it was a French invention practically untested—and after the reiterations from the Treasury bench that the tubular boiler adopted had, on the contrary, undergone the most convincing tests, that it offered enormous advantages in respect to the time demanded for getting up steam, etc., and that the British Navy could not afford to be in arrears, it seems strange to find a French naval critic assailing the tubular boiler, and urging a return to the cylindrical boiler. Another interviewed person on the same side severely blames the Ministry for the Marine for fitting new war vessels, such as the *Chateaurenault*, the *Guichen* and the *d'Estrees*, with the tubular, or, as they are termed here, multitubular boilers. He quotes the example of the Italian Marine Department, which, as the result of the catastrophe on board the *Jaureguiberry*, at once substituted the cylindrical boiler defended by Mr. Allan for the tubular variety fitted to the cruiser *Varesa*, then in course of construction. The breakdown of the *Amiral-Trehouart* was pronounced at Brest to be due to deposits inseparable from the system of the water-tube boilers. Three types of these boilers exist at present in the French Navy, and as it happens, they are placed upon three cruisers of an identical class—the *Chasseloup-Laubat*, the *Friant* and the *Bugeaud*. The *Belleville* may or may not resemble either of the types in question, but those who have criticised its adoption for British war vessels may be interested to learn that a strong cry has been raised on this side of the Channel for a further series of tests, and for the return to the cylindrical boiler at any rate until the superior character of the water tube boilers has been placed beyond all doubt by a perfection of the system.

Small Plant for Handling Coal and Ashes for Locomotives. Cleveland, Cincinnati, Chicago & St. Louis Railway.

Some months ago we described the plant for handling coal and ashes for the locomotives of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Wabash, Ind. That plant is completely equipped with conveyors and manual labor is reduced to a minimum. But it is not always possible to put up such a plant, a case in point being the terminals of this same road at Louisville, where there is not room near the roundhouse for a regular coal chute, with conveyors.

At this point the problem of reducing the expense of handling coal and ashes has been solved in a way which will be readily understood from the accompanying engravings. Fig. 1 shows the arrangement of tracks at the coaling station. The upper track is the in-going track to the roundhouse. In this track is located an ash pit, served with a crane, and further away from the roundhouse is a second crane on the coaling platform. The cranes are shown in Fig. 2, and in Fig. 3 is shown one of the ash cars placed in the ash pit.

The cranes are of the pillar type, and are worked by compressed air, and have a capacity of 3,000 pounds. The cylinder is 12 inches in diameter, and has a 6-foot stroke. Its piston carries a sheave at its outer end and a ⅝-inch wire rope with one end secured at a fixed point passes around this sheave and over the one at the end of the crane. The load thus moves twice as fast and twice as far as the piston of the air cylinder. The other details of the cranes will be readily understood from the drawing.

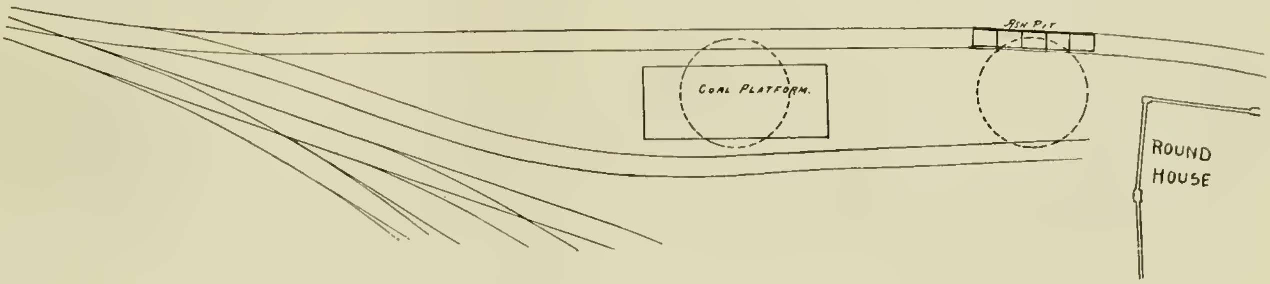


Fig. 1—Plan of Coaling Tracks at Louisville.

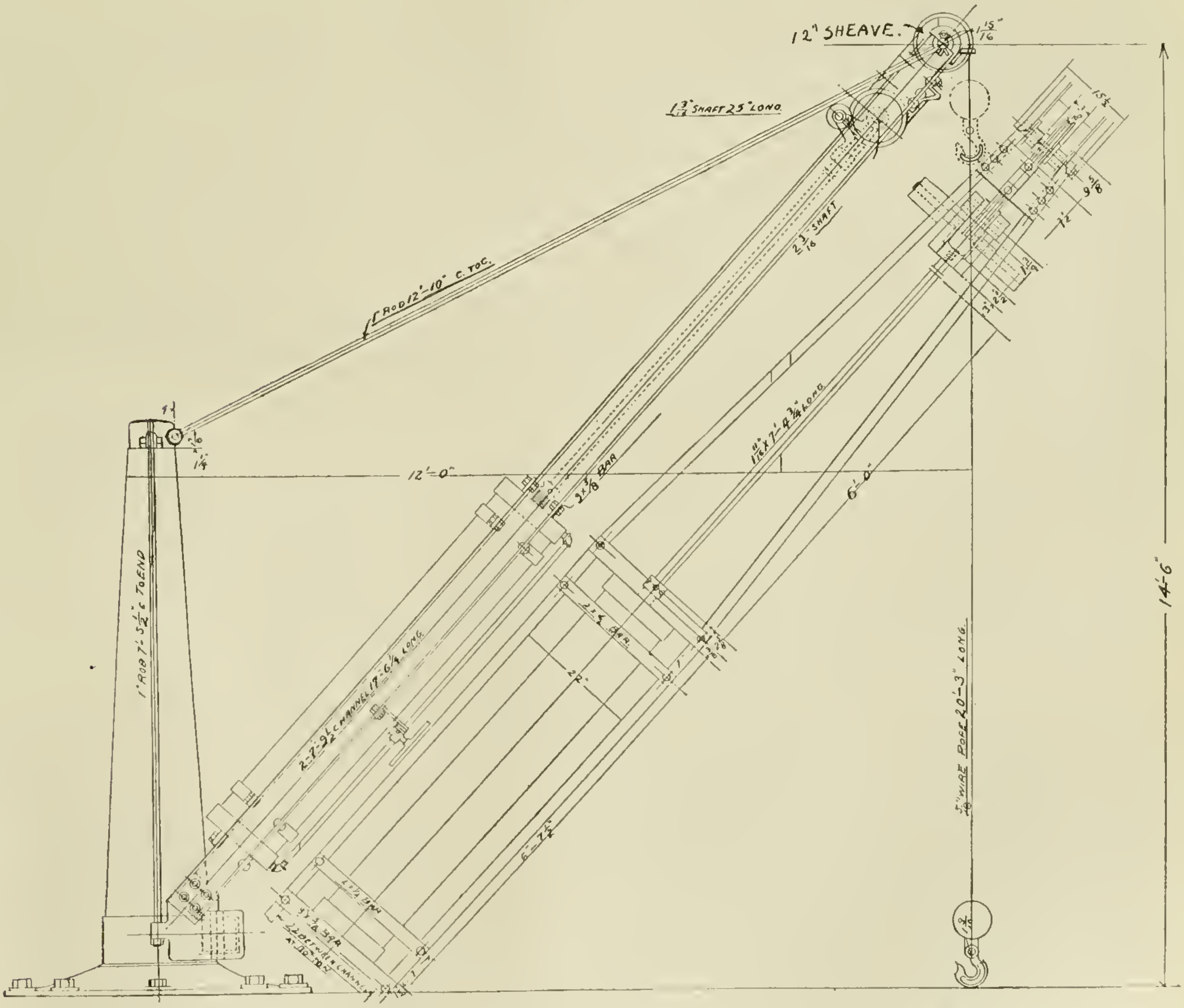


Fig. 2.—Pneumatic Crane for Handling Coal and Ashes at Louisville—C., C., C. & St. L. Ry.

In the bottom of the ash pit there is a track of 30 inches gage, on which travel cars such as shown in Fig. 3. The bodies of these are made of $\frac{3}{16}$-inch plate, put together at the corners with 1½-inch angle iron, and stiffened at the top edge with 1½ inch by ¼-inch

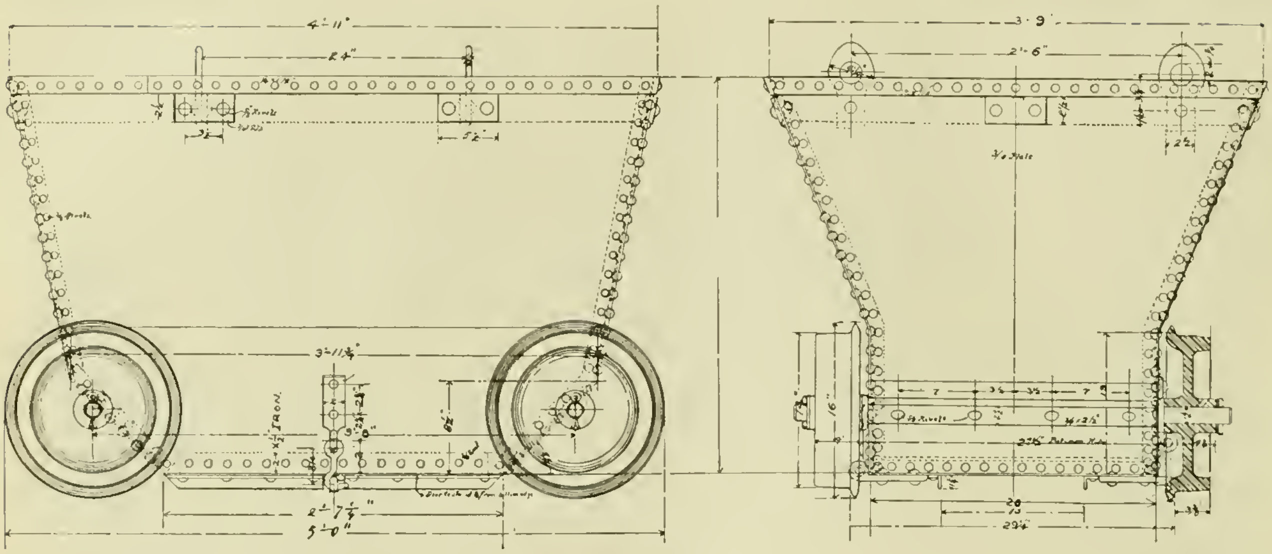


Fig. 3.—Car for Ash Pit at Louisville.—C., C., C. & St. L. Ry.

iron and at the bottom with 2-inch by ½-inch iron. The bottom is a door hinged at one side, and held at the other with the hook seen in the side elevation of Fig. 3. Across the top of the box are two iron crossties, to each of which is secured two eyes, by which the car is lifted bodily out of the pit when it has been filled with ashes.

The pit is long enough for five of these cars, and they are handled by one of the air cranes, by which they are lifted out of the pit, swung over to the next track, and their contents emptied through the drop bottoms into a car kept standing on the coal-storage track.

The coaling operations are conducted by means of the other air crane. There are 12 coal buckets on the platform, each capable of holding about one ton, and these are so arranged that they can be conveniently filled from a car standing on the coal-storage track. When an engine is to be coaled the contents of as many of these buckets as necessary are delivered on the tender by means of the crane. At present between 15 and 20 engines are coaled daily with this plant.

The arrangement has proved so satisfactory for a small plant that a similar outfit is being installed by the same road at East St. Louis, Ill.

Experiments on a Steam Engine at Liege University, Belgium, by Professor Dwelshauvers-Dery, 1896.

NOTES BY MR. BRYAN DONKIN, M. I. C. E.

For the last few years Professor Dwelshauvers-Dery has been making, with his students, some interesting experiments on his single cylinder horizontal surface-condensing steam engine, provided with a brake pulley, cooled by water. Steam is introduced into the three jackets, barrel, and covers, or not, at pleasure. Superheated or saturated steam is used. All measurements are made so that a heat balance is obtained in each experiment. The cylinder of the engine is 1 foot diameter, and the stroke 1 foot 11⅝ inches. These experiments have been going on for some years, and it may be interesting to give a brief summary of some of the results which Professor Dwelshauvers-Dery has arrived at.

Experiments with a brake pulley to obtain the mechanical equivalent of heat.—The professor made several very exact experiments to obtain the mechanical equivalent of heat due to the rise in temperature of a certain quantity of water cooling the hollow brake. This brake absorbed a certain quantity of power, and so much heat was put into the pulley. By a water cooling arrangement this heat was continuously taken away by the water, cold water going in and hot water running out. The quantity of such water was very accurately measured by means of a circular orifice, previously gaged by tanks with extreme care. He thus had all the means of ascertaining the power absorbed by the brake, the quantity of water, and its rise in temperature. The mechanical equivalent of heat, as found by Rowland, is now generally admitted to be 778 foot-pounds per Fahrenheit unit. This, in metric measurement, is equivalent to 426·83 kilogramme-meters per calorie. The mean of six-brake experiments made by the professor works out at 427·22 kilogramme-meters, or higher than the first figure by a tenth of 1 per cent.—a very satisfactory result. The mechanical efficiency of the engine in these experiments was 88 per cent., or, in other words, 12 per cent. of the total indicated power was absorbed by working all the parts of the engine itself.

Experiments relating to the advantage of draining the steam-chest, using steam jackets, and also superheated steam.—To determine the consumption of steam in pounds of water per indicated horse power hour, the professor calculated the experimental results as follows: He took the number of thermal units actually used by the engine per indicated horse power per hour. Then taking the number of thermal units per pound of steam as 1,179, he obtains the number of pounds of water per indicated horse power hour. This is the right method when it is desired to compare the pounds of water per indicated horse power hour from different steam engines, and particularly when some engines use superheated and some saturated steam; or if they work with different steam pressures. With regard to draining the steam chest or the steam jackets, the hot water can either be sent down the drains to waste or the heat in them utilized by being pumped into the boiler. It is, therefore, necessary to calculate separately the pounds of water per indicated horse power hour in these two very different cases, and this has been done in the following tables. In this way the economy has been obtained separately for each of these three great questions, viz., draining of the chest, steam jackets, and superheating the steam. Engine working condensing in all cases:

TABLE A.

No.	Kind of Steam.	Draining the hot water from steam chest or not.	Steam in three jackets, barrel, and two covers or not.	Consumption of steam in lbs. per I. H. P. hour.	
				The hot drained water being wasted.	The hot water sent to boiler.
1..	Saturated steam.	Not draining.	No steam in jackets.	32.64	0 00
2.	do.	Draining.	ditto	30 43	29.61
3..	do.	Not draining.	Steam in jackets.	24.57	24.00
4..	do.	Draining.	ditto	21.81	21.10
5..	Superheated steam (72 deg. F. of superheat)	Not draining.	No steam in jackets.	25.56	0.00
6..	do.	Draining.	ditto	27.06	26 92
7..	do.	Not draining.	Steam in jackets.	19.47	19.16
8..	do.	Draining.	ditto	19 83	19.42

Steam pressure, 80 lb. Cut-off, one-tenth. Working, condensing.

TABLE B.

The economy due to the draining of the steam chest only is obtained by comparing

	In the case of	The economy is part of hot water Being wasted.	Being utilized.
		Per cent.	Per cent.
2 and 1	Saturated steam and no steam in jackets....	6.87	9.29
4 and 3	" " steam in jackets........	11.27	12.08
6 and 5	Superheated steam and no steam in jackets.	− 5.87	− 5.33
8 and 7	" " steam in jackets...	− 1.82	− 1.31

The sign minus (—) indicates a loss instead of a gain.

TABLE C.

Economy due to using steam in the three jackets is obtained by comparing

	In the case of	Percentage of economy, is as follows, the drained water being Lost	Utilized.
		Per cent.	Per cent.
3 and 1	Saturated steam and not draining the chest.	24.72	26.47
4 and 2	" " " draining the chest.....	28.27	28.73
7 and 5	Superheated steam and not draining the chest..	23.80	25.02
8 and 6	Superheated steam and draining the chest..	26.72	27.86

TABLE D.

The economy due to superheating only (amount of superheat 72 deg. Fahr.) is obtained by comparing

	In the case of	Percentage of economy the drained hot water being Lost	Utilized.
		Per cent.	Per cent.
5 and 1	No steam in jackets and not draining chest..	21.70	0.00
6 and 2	" " " draining the chest.	10.98	9.07
7 and 3	Steam in jackets and not draining the chest.	20.75	20.16
8 and 4	" " " draining chest.........	8.06	7.97

The best experiment in this single-cylinder engine in the consumption of steam was with superheated steam of 72 degrees Fahrenheit (of superheat), both in the cylinders and jackets, and not draining the cheet, which resulted in 19.45 pounds of steam per indicated horse power hour. The least economical was with saturated steam without jackets and without drainage, when the engine used 32.6 pound per indicated horse-power hour. Comparing these two results, there is an advantage of 41 per cent. in favor of the combined effect of using superheated steam both in the jackets and inside cylinder, as compared with no jacket and no draining, and saturated steam. It is well to add that this steam engine was not made for greatest economy, but for educating the University students in all the practical details of making engine tests, taking diagrams, and accurately recording results—an education which has had great success at Liege, and is very popular with the young men.—*The Engineer.*

The New Torpedo Boats.

On October 6th the contracts for the new torpedo boats for the U. S. Navy were awarded as follows: To the Bath Iron Works, Maine, two 30-knot boats of 230 tons displacement for $235,000 each; these boats will be 180 feet long, 18⅙ feet beam, 11⅙ feet deep, 5 feet 3⅙ inches draft. To the Union Iron Works, one 30-knot boat of 273 tons displacement for $227,500; it will be 210 feet long, 20⅙ feet beam, 14⅙ feet deep, 6 feet draft. To Wolff & Zwicken, Seattle, two 22½-knot boats of 117 tons displacement for $75,100 each; these will be 146 feet long, 15⅙ feet beam, 10¼ feet deep, 5⅙ feet draft. To the Herreshoff Manufacturing Company one 22½-knot boat and two 20-knot boats: the 20-knot boats will be of 46½ tons displacement and will cost $37,500 each; they will be 100 feet long, 12½ feet beam, 3½ feet draft and 850 horse-power. To Columbia Iron Works, Baltimore, and the Charles Hillman & Co., Philadelphia, one 20-knot boat each for $49,000 and $48,500 respectively. These two boats will be alike and have 65 tons displacement, 101½ feet long, 12½ feet beam, 4¼ feet draft and 850 horse power. It is reported that these 20 knot boats, so much slower and smaller than craft of this character now built by other nations, are of such dimensions that they can be sent through the canals to the great lakes if occasion should require it.

New Equipment on the Baltimore & Ohio Railroad.

On the occasion of a recent visit to the Mount Clare shops of the Baltimore & Ohio Railroad we had the pleasure of seeing one or more engines of several classes embraced in the order of 75 given out some months ago. Most of these engines have been delivered now, and Mr. Harvey Middleton, General Superintendent of Motive Power, has kindly furnished us with the principal dimensions of several classes of them and with photographs from which the accompanying engravings were made.

The new passenger engines are of the ten-wheeled type, and are of two classes, differing from each other chiefly in the diameter of the drivers and the size of the cylinders. The larger engines have cylinders 21 by 26 inches, and driving wheels 78 inches in diameter. Unless we are mistaken these are the largest drivers ever used in this country on ten-wheeled engines. The cylinders and boilers are large, and give these engines great power. They are intended for service on the heavy express trains between Philadelphia and Washington. There are a number of interesting details in their construction, and we hope in the near future to illustrate these details from working drawings. In the meantime we present an engraving from a photograph which gives an idea of their handsome appearance. The leading dimensions of the two classes of engines are as follows:

21-INCH BY 26-INCH AND 20-INCH BY 26-INCH, TEN-WHEELED PASSENGER ENGINES BUILT FOR THE B. & O. R. R. BY THE BALDWIN LOCOMOTIVE WORKS.

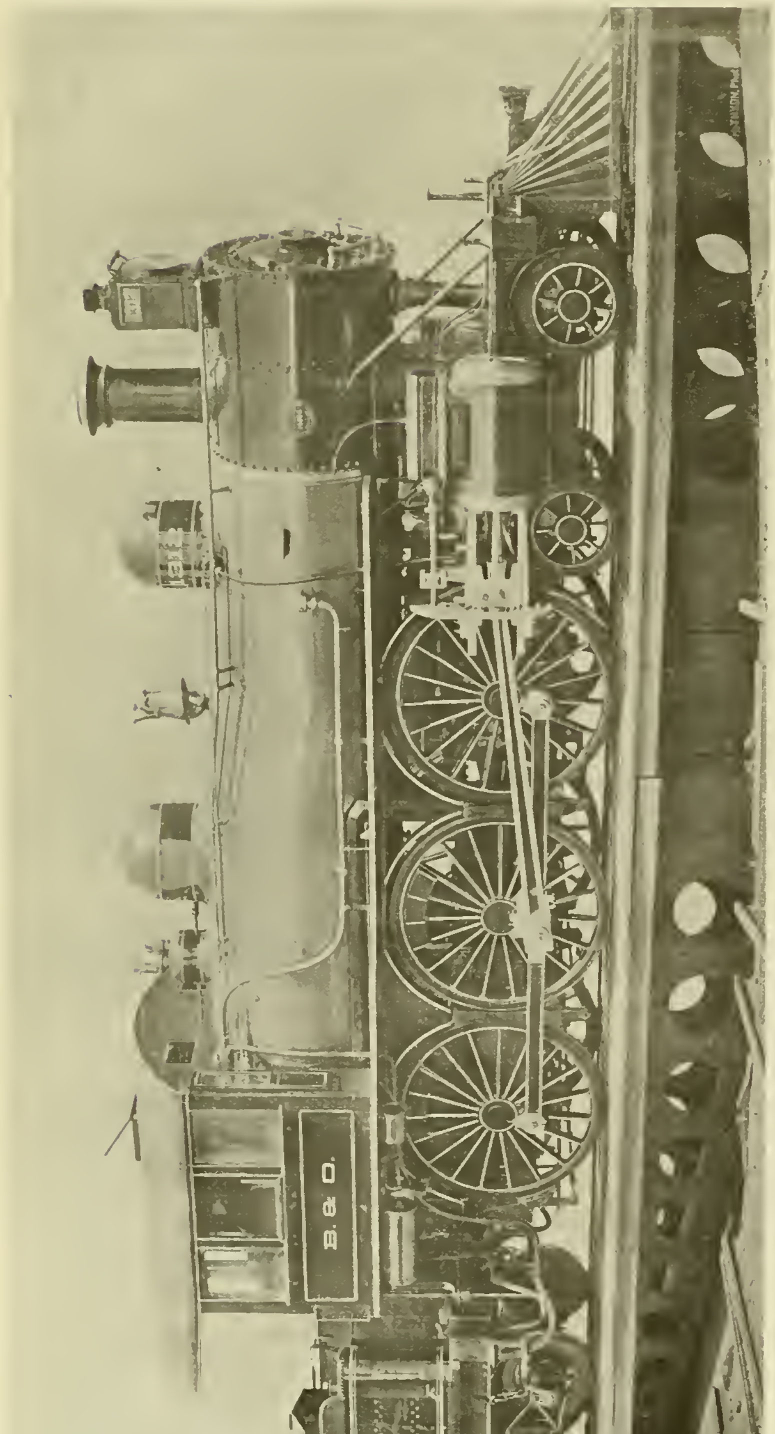
Type and number ordered....Ten wheel	6	4
Simple or compound..................	Single Expansion	
Total wheel base....................	24 ft. 6 in.	24 ft. 6 in.
Rigid wheel base....................	13 ft. 8 in.	13 ft. 8 in.
Total wheel base of engine and tender..	51 ft. 8¼ in.	51 ft. 8¼ in.
Total length of engine and tender.......	61 ft. 9 in.	61 ft. 9 in.
Diameter of cylinders..................	21 in.	20 in.
Stroke of piston....................	26 in.	26 in.
Diameter of piston rods................	3½ in.	3½ in.
Size of steam ports..................	19 in. by 1⅜ in.	19 in. by 1⅜ in.
Size of exhaust ports..................	19 in. by 2¾ in.	19 in. by 2¾ in.
Greatest travel of slide valves........	6 in.	6 in.
Outside lap of slide valves............	1 in.	1 in.
Lead of slide valves in full stroke.......	3/32 in.	3/32 in.
Diameter of driving wheels, outside, ...	78 in.	68 in.
Kind of truck wheels..................	Wrought center	Wrought center
Diameter of truck wheels..............	33 in.	30 in.
Size of driving axle journals...........	8 in. by 10 in.	8 in. by 10 in.
Size of truck axle journals............	5 in. by 10 in.	5 in. by 10 in.
Size of main crank pin journals........	6 in. by 6 in.	6 in. by 6 in.
Description of boiler..................	Wag. top	Wag. top
Diameter of boiler at smallest ring....	60 in.	60 in.
Material of boiler....................	Steel	Steel
Thickness of plates in boiler barrel.....	⅝ in.	⅝ in.
Thickness of plates in firebox shell.....	9/16 in.	9/16 in.
Thickness of plates in sides, back end and crown of firebox..................	⅜ in. 7/16 in.	⅜ in. 7/16 in.
Thickness of plates in front and back tube sheets....................	½ in.	½ in.
Kind of horizontal seams..............	Butt	Butt
Kind of circumferential seams...........	Double riveted	Double riveted
Material of tubes....................	Iron No. 12 w. g.	Iron No. 12 w. g.
Number of tubes......................	231	231
Outside diameter of tubes............	2¼ in.	2¼ in.
Length of tubes over tube sheets........	14 ft. 7½ in.	14 ft. 7½ in.
Inside length of firebox................	120⅜ in.	120⅜ in.
Inside width of firebox...............	41 in.	41 in.
Depth of firebox from crown sheet to bottom of mud ring................	F. 73½ in. B. 61.	F. 73½ in. B. 61
Water spaces, sides and back...........	3	3
Water spaces, front..................	4	4
Crown plate stayed with (one ⊥-iron front, bolts 1⅛ diameter)...............	Radial stays	Radial stays
Diameter of dome....................	31½	31½
Height of dome (from top of rail)........	14 ft. 9 in.	14 ft. 4 in.
Steam pressure, pounds................	190	190
Kind of grate........................	Rocking	Rocking
Grate surface, square feet............	34.27	34.27
Heating surface of firebox, square feet..	215.2	215.2
Heating surface of tubes, square feet....	1,978.52	1,978.52
Total heating surface, square feet.......	2,193.72	2,193.72
Height from top of rail to top of smokestack....................	15.0 in.	14.7 in.
Tires, kind and make (Standard)........	Steel	Steel

Tender.

Wheels............................	36	33
Axles.............................	Steel	Steel
Size of axle journal..................	4¼ by 8	4¼ by 8
Water capacity of tank................	3,500	3,500
Frames, wood or metal................	Wood	Wood
Breakbeams, kind and make (Nat'l hollow)...................	2½ in.	2½ in.
Break heads and shoes, kind and make	Mall. head	Cast iron shoe

Details of Equipment.

Guides and crossheads, type and metal
Two bar type iron (C. H.) guides, cast steel crosshead
Connecting rods......................Steel, parallel rods 1 section, solid ends
Brakes..........................Westinghouse-American outside equalized
Lubricators...................... Nathan S. F. Nathan S. F.
Injectors......................No. 10 Metropolitan No. 10 Metropolitan
Valves.................................Three Crale Muffled, 2½ in.



21-Inch by 26-Inch Ten-Wheeled Passenger Engine—Baltimore & Ohio Railroad.

MR. HARVEY MIDDLETON, Superintendent of Motive Power. Built by the BALDWIN LOCOMOTIVE WORKS.

Gages ....Two Crosby thermostatic
Springs ....B. L. W.
Headlights.......... . .. . 18 in. sq.
Special devices. Compressed-air signal; Leach tandem; Gold Steam Heating device; Gould coupler.

In the construction of all of these engines there are a number of details of interest. One feature that should not be overlooked is the manner in which the frames are braced. In engines whose boilers project through, or nearly through, the cab, the foot-plate is conspicuous by its absence, or is at best a comparatively short affair. The long foot-plate undoubtedly does much to prevent working of the frames, particularly in a longitudinal direction, and yet when the long foot-plate is omitted nothing takes its place in bracing the frames against the tendency to a racking motion of this kind. The cylinder saddles alone must resist the strain, and the mechanical department is of the opinion that herein is a partial explantion of the trouble with loose cylinder fastenings and fractured saddles. To remedy these troubles the new engines, and also such engines as go through the shops for heavy repairs, are provided with wide and heavy plates extending across the frames at some convenient point. In the new consolidation engines they are placed on top of the frames immediately back of the cylinder saddle and are 20 inches wide in the middle and 24 inches wide at the ends. They lip down over the frame inside and outside and are solidly bolted into position. In the case of some 10-wheeled engines being repaired in the shops the plates were placed across the frames at a point about midway between the cylinder saddle and firebox. Their exact location is of course a matter of convenience and clearance of other parts of the engine. Some of the new consolidations also have several heavy ribs on the outside of the saddles.

The guide-blocks on the consolidations each have three bolts, or one more than usual, making a very secure fastening. The parallel rods all have solid ends except the front ends of the front rods, where straps are used, as the cross-head would have interfered in the removal of a solid end rod.

Considerable care has been exercised in all the engines to have the cab fixtures convenient to the men, and the interiors of the cabs look very comfortable. The fireman has a steam gage for his own use, the face of which is exposed through an opening in the back of the cab. The fronts of the cabs are cast iron, from the boiler to the doors and windows.

The tanks have large filling-holes, that avoid the necessity of stopping exactly opposite a water station. The opening is 4 feet long and 1 foot wide, and is placed the long way across the tank. The water-spout can thus be at considerable of an angle and yet deliver water into the tank. There are a number of other features of the 10-wheeled engines, to which we will call attention when we publish the detail drawings.

On most roads the problem of counterbalancing engines refuses to remain settled, and if the mechanical department grapples with it, and, as they think, vanquish it, the obsequies are hardly over before its ghost appears. No matter how good the rules adopted and the precautions exercised, it seems as if some violations of the practice of the road will remain to be discovered from time to time. On this road they recently took the wheels out from under some modern passenger engines and found the axle journals smooth and apparently in good condition, but eccentric with the remainder of the axle by as much as three-sixteenths of an inch in the worst cases. The tires were also in bad shape, and upon examining the back pair of drivers they found that the builders had balanced all the revolving, and from 12 to 47 pounds more than *all* the reciprocating, weights for those wheels. Unfortunately the main wheels had been removed from their axles by the time this discovery was made, and it is not known whether or not they were short of balance. But this is an illustration of the necessity of extreme vigilance in following out the details of counterbalancing, if correct practice is to be obtained.

The consolidation engines built for the company are of two sizes. The larger of these is shown in Fig 1, and has cylinders 22 inches by 28 inches. The smaller engines have cylinders 21 inches by 26, and resemble the larger engines so much in general appearance that we have omitted the photograph of the smaller. The smaller engines do not have the second small steam dome seen in

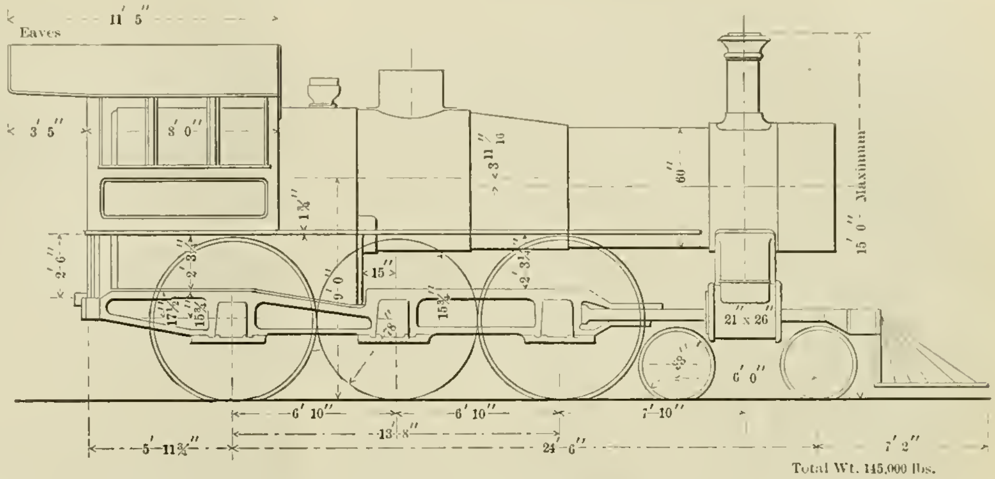


Diagram of 21 by 26-Inch Ten-Wheeled Engine—Baltimore & Ohio Railroad.

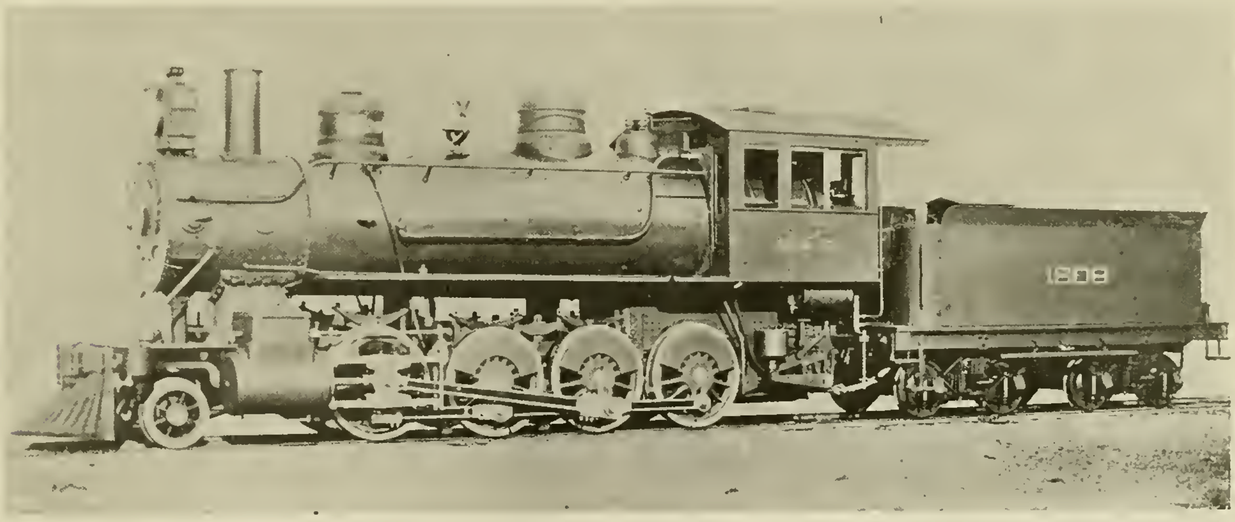

22 by 28-Inch Condsolidation Engine for Baltimore & Ohio Railroad—Built by the Cooke Locomotive and Machine Company.

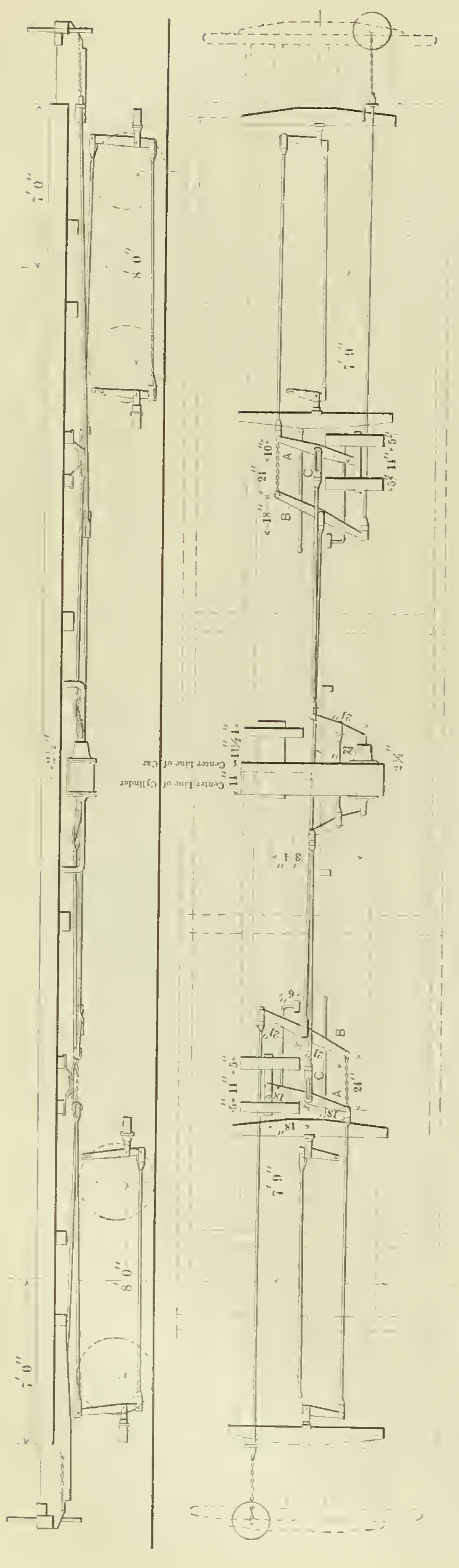
Fig. 1, otherwise they look about the same except for the matter of size. Both classes are powerful engines, as will be seen from the following dimensions of engines built by the Cooke and Richmond companies:

22-INCH BY 28-INCH CONSOLIDATION ENGINES BUILT FOR B. & O. R.R. BY COOKE LOCOMOTIVE AND MACHINE CO.

Type and number ordered	consolidation, 10
Total weight in working order	166,000 pounds
Total wheel base	23 feet 2 inches
Rigid wheel base	15 feet
Total wheel base of engine and tender	51 feet 7 inches
Total length of engine and tender over all	61 feet 3 inches
Diameter of cylinders	22 inches
Stroke of piston	28 inches
Size of steam ports	20 inches by 1⅝ inches
Size of exhaust ports	20 inches by 3¼ inches
Greatest travel of slide valves	6 inches
Outside lap of slide valves	$\frac{15}{16}$ inch
Lead of slide valves in full stroke	$\frac{1}{16}$ inch
Diameter of driving-wheels, outside	54 inches
Kind of truck wheels	30-inch steel-tired, wrought-iron spoke center
Size of driving-axle journals	8½ inches by $10\frac{11}{16}$ inches
Size of truck-axle journals	5 inches by 8¾ inches
Size of main crank pin journals, main rod	6½ inches by 6 inches
" " " parallel rod	6½ by 5¾ inches
Description of boiler	wagon top
Diameter of boiler at smallest ring	64 inches
Material of boiler	Park Bros., steel
Thickness of plates in boiler barrel	$\frac{9}{16}$ inches and ⅝ inches
Thickness of plates in firebox shell	⅝ inches
Thickness of plates in sides, back and crown of firebox	⅜ and $\frac{7}{16}$ inches
Thickness of plates in front and back tube sheets	½ inch
Kind of horizontal seam	Butt with double welt
Kind of circumferential seams	double riveted
Material of tubes	Iron
Number of tubes	248
Outside diameter of tubes	2¼ inches
Length of tubes over tube sheets	14 feet 9 inches
Inside length of firebox	115 inches
Inside width of firebox	41 inches
Depth of firebox from crown to bottom of ring	67 $\frac{3}{16}$ to 69 $\frac{7}{16}$ inches
Water spaces, sides and back	3 inches
Water spaces, front	4 inches
Crown plated stayed with	crown bars
Diamater of dome inside	30 inches
Steam pressure, pounds	180
Kind of grate	Rocking
Grate surface, square feet	37.75
Heating surface of firebox, square feet	182.5
Heating surface of tubes, square feet	2,155.0
Total heating surface, square feet	2,337.5
Height from top of rail to top of smokestack	11 feet 7 inches
Tires	Standard Steel Company's
Guides and crossheads	Guides steel, crossheads steel, alligator style
Connecting rods	Channeled bodies
Brakes	Westinghouse: American driver brakes
Lubricators	Nathan triple
Injectors	Monitor No. 10
Valves	Richardson balanced
Gages	8½ inch Crosby
Springs	Pickering
Headlight	Kelly, 18-inch, with B. & O. frame for numbers
Special devices	Coale 3-inch muffled safety valves

Tender.

Wheels	33-inch chilled
Axles	Steel
Size of axle journals	4¼ inches by 8 inches
Water capacity of tank, gallons	4,000
Frames, wood or metal	Wood
Brake beams	National hollow
Brake heads and shoes	Christie



Brake Rigging with Hand Brakes Independent of Air-Brakes—Baltimore & Ohio Passenger Cars.

21-INCH BY 26-INCH CONSOLIDATION ENGINES, BUILT FOR B. & O. R. R., BY RICHMOND LOCOMOTIVE WORKS.

Type and number ordered	Consolidation, 25
Weight on drivers	131 000 pounds
Weight on trucks	14,300 pounds
Total weight in working order	145,300 pounds
Total wheel base of engine	23 feet 2 inches
Rigid wheel base	15 feet 2 inches
Total wheel base of engine and tender	51 feet 2 inches
Total length of engine and tender over all	64 feet 7 inches
Diameter of cylinders	21 inches
Stroke of piston	26 inches
Kind of piston packing	Cast iron rings
Size of steam ports	18 inches by 1⅜ inches
Size of exhaust ports	18 inches by 3 inches
Greatest travel of slide valves	5⅝ inches
Outside lap of slide valves	¾-inch
Lead of slide valves in full stroke	0 inches
Diameter of driving wheels, outside	50 inches
Kind of truck wheels	Standard plate, steel tired
Size of driving axle journals	7½ inches by 9 inches
Size of truck axle journals	5 inches by 8¾ inches
Size of main crank pin journals	5¾ inches by 5½ inches
Description of boiler	Crown bar, wagon top
Diameter of boiler at smallest ring	60 inches
Material of boiler	Steel
Thickness of plates in boiler barrel	$\frac{9}{16}$ inches and ⅝ inches
Thickness of plates in firebox shell	$\frac{9}{16}$ inches
Thickness of plates in sides, back and crown of firebox	⅜ and $\frac{7}{16}$ inches
Thickness of plates in front and back tube sheets	½ inch
Kind of horizontal seams	Double riveted butt
Kind of circumferential seams	Double riveted lap
Material of tubes	Charcoal iron
Number of tubes	221
Outside diameter of tubes	2¼ inches
Length of tubes over tube sheets	13 feet 8 inches
Inside length of firebox	10 feet
Inside width of firebox	31⅜ inches
Depth of firebox from crownsheet to bottom of mud ring	6 feet 10½ inches front, 5 feet 11 inches back
Water spaces, sides and back	3 inches
Water spaces, front	4 inches
Crown plate stayed with	Crown bars
Diameter of dome	31 inches
Steam pressure, pounds	165
Kind of grate	Rocking bar
Grate surface, square feet	28.64
Heating surface of firebox, square feet	173
Heating surface of tubes, square feet	1,779
Total heating surface, square feet	1,952
Height from top of rail to top of smokestack	14 feet 3½ inches

Tender.

Tender wheels	Cast-iron chilled, 33 inches diameter
Tender axles	Steel
Size of tender axle journals	4¼ inches by 8 inches
Water capacity of tank, gallons	3,500

Equipment.

Tires, kind and make	4 flanged 4 plain, Midvale
Tender wheels, kind and make	Cast-iron chilled, ensign
Tender frames, wood or metal	White oak
Tender capacity	Coal, 6 tons; water, 3,500 gallons
Tender brake beams, kind and make	National Hollow, 2⅛ inches
Tender brake heads and shoes	Cast-iron Christie
Boiler	"Carbon" steel
Firebox	(Between frames) "Carbon" steel
Draft appliances	Adjustable dampers, brick arch, deflector and nett'g
Guides and crosshead, type and metal	Two bar steel, H-crosshead
Connecting rods, metal	Steel
Brakes, type	Westinghouse; American driver brakes
Lubricators, make	Nathan triple sight feed
Injectors, make	Monitor No. 10
Valves, make	Richardson balanced
Gages, make	Ashcroft
Springs, make	A. French Spring Compa y's
Headlight, make	Rochester Headlight Company, B. & O standard
Sanding device	Leach's sanding device
Boiler covering	Asbestos cement lagging

We show in the next column drawings of a brake rigging which the Baltimore & Ohio is using on some of its new passenger cars and which is now the company's standard construction. The operating department has for some time desired an improvement upon the common foundation brake, by which it would be possible to apply the hand brakes independently of the air brakes. It has been found that when a car was set out at a junction point or division terminal, it was usually switched on to the siding, and the air brakes set. This put a tension on the hand brake chain and that brake could not be set; consequently, it was left with the air brakes on, as there was no time to bleed them and set the hand brake. If the car stood for any length of time the air leaked off and the car would be in danger of being blown onto the main line or running on to it by gravity. Rules might be issued to the trainmen to prevent cars being left in this condition, but obedience to them would cause delays, and therefore the rigging shown was gotten up.

It will be noticed that the cylinder levers are connected by rods to the levers *A A*, and that the latter are connected to the truck levers. These are the only levers and connections needed for the air brake. The rods from the hand brakes do not connect to the levers *A A*, as in ordinary construction; on the contrary the ends of these levers are secured to fulcrums on the car frame.

and the application of the air puts no strain on the brake-staffs, The levers *B B* come into service only when the hand-brakes are used. One end of each is connected to a brake-staff and the other ends are attached by chains to the levers *A A*. They are also connected to each other by a long "middle connection." The chains between *A* and *B* becomes slack when the air is applied, and if the hand-brakes alone are put on the slotted connections *C C* permit the levers *A A* to move without disturbing the air-brake piston. It will readily be seen that if a car is set out on a siding and brought to rest with the air brakes, the train men can set the hand brakes in addition, and leave the car with the assurance that when the air leakes off it will still be firmly held by the hand brakes.

Car Heating by Steam.*

BY MR. R. M. DIXON.

An inquiry among those having charge of equipment on cars shows that success of steam heating is almost universal, so few troubles occur. There seems to be but few instances on any road during entire seasons, and almost all trouble can be either traced to lack of steam circulation in the train pipe, or to insufficient attention to the drips or traps. Cars cut out of trains sometimes have pipes freeze, but this is always due to neglect in opening drainage valves.

Train pipes as used for all couplers should have their ends conform to the Master Car Builders' position for direction and location. It is well to bear in mind in placing them that the tendency of the ends of cars is downward, and as the couplers, if hanging uncoupled, will almost strike the switch tracks and crossings, the end of the train pipe should be placed above rather than below the standard position. The train pipe should drain from the point where the car supply is taken off to its ends. If it cannot be done and keep the train pipe below the floor sheathing, then a first-class plan is to run it between the car sills and above the sheathing. In such a place, covering but ⅝ inch thick will suffice; while if below the sheathing, covering 1 inch thick is advisable. The arrangement of the train pipe above the sheathing is standard on some roads, and it has much to recommend it.

Such train-pipe cocks should be used as are readily understood on sight. There is but little time to study out a system when a train is ready for service, and experience teaches that train-pipe cocks are the part of the equipment most difficult to understand. In service all train-pipe cocks but one, the rear one, are to be open, and in cold weather the rear one should be open enough to let just a little steam escape through it so as to maintain a circulation of steam throughout the train pipe, whether or not the rear cars are using steam.

The covering should be well applied to the train pipe; otherwise it will not stay on. Instances can be cited where the covering has remained in place but a short time, and more than one-half the train pipe become exposed and in condition to cause more condensation than all the radiating surface in the car.

As to the amount of direct steam-radiating surface in a car, experience has led to the use of two 2-inch standard iron pipes along each side. This is somewhat below what heating engineers would figure as necessary to keep the cars warm in zero weather; but as more has been found very excessive for moderate weather, a sort of compromise has resulted. The only way to satisfactorily warm cars by direct steam in all kinds of weather is to have appliances that will permit of varying the amount of radiating surface into which steam is supplied, and so approximate to a suitable heating surface to meet the conditions existing. Such a arrangement also permits of quickly heating cold cars, without overheating them when warm.

All valves and fittings placed inside of the cars should be heavy, and not liable to leak or have the bonnets come off when opening. The valves should have their use cast plainly on the handles.

For direct steam, an automatic trap for discharging the condensation is not necessary, nor desirable. The amount of condensation to be discharged after a car is warmed varies but little, and any increase or decrease of condensaaion is in the same direction as the change in steam pressure within the radiating pipes. Therefore, an orifice adjusted to take care of the condensation at any pressure will discharge a greater amount of condensation when there is a greater pressure to expel it.

*From a paper read before the New York Railroad Club, Oct. 15, 1896.

Angle valves are usually used for drip valves, and in many cases have been so arranged as to prevent their being entirely closed. Experience has taught that it is better not to so arrange them. A very simple and safe method of adjusting the drip valves properly, given by Mr. A. M. Waitt, is to touch the hand to the drip valve, and it the hand can be borne on it and it is warm, it is all right. If it is so hot that it burns, it is too far open; and if cold, it needs to be opened a little.

With hot-water circulating systems for distributing the heat throughout the cars, the regulation of the temperature is quite easy, and the heat can be carried to various parts of the car without the multiplication of drips for the condensation that is required for direct steam.

It is desirable, in conjunction with water-circulating systems, to use some kind of a device for discharging the condensation, which device shall be in a degree automatic. The rate of condensation is quite variable, and generally the drip is located under the car, where it cannot receive close attention. If not automatic and adjusted to discharge sufficiently while heating the circulating water and raising the temperature of the car, it will be too much open after the water is hot and the car warm, and much steam will be wasted, causing not only loss of steam, but damage to car floors and varnish, as well as annoyance around the cars.

The following set of rules for handling steam equipment may be found reliable, especially if supplemented by a description of the system in use, and modified as the system may require.

RULES FOR HANDLING STEAM-HEATING EQUIPMENT—MAKING UP TRAINS.

When a train is made up, all steam hose should be coupled, and all the cocks in the steam train pipe the whole length of the train should be opened.

When signal is given, steam should be turned on at the cab, not to exceed 65 pounds, and allowed to blow through the entire length of the steam train pipe.

After steam issues at the rear end of the train pipe, the rear cock of last car should be closed, and reducing valve in cab set to 40 pounds pressure. If more than eight cars are in the train, add 5 pounds for each additional car. In very cold weather the rear train-pipe cock should be left open enough to allow a little steam to pass and escape through the rear coupling.

REGULATION OF TEMPERATURE.

To heat cars, open steam inlet valves on each car; and when live steam appears at the drips, set each drip so that a little steam escapes with the water. If a trap be used, see that it is adjusted to allow a little steam to escape with the water.

Frequently examine traps and drip valves to see that they are operating properly. They should be as hot as can be borne by the hand. If cooler, or cold, they should be opened a trifle; or if too hot, or steam is blowing, closed a little.

Never close steam inlet valves entirely without first opening drip valves or blow-off valve, and allow water to blow out before closing steam inlet valve.

When steam is required on this car again, open steam inlet valve, and afterwards close drip valves or blow-off valve.

CHANGING ENGINES.

When approaching stations where engines are to be changed, or terminals where cars are to be laid up, five minutes before arriving at such stations the rear train-pipe cock must be opened wide, and before coming to a stop at such stations the engineer must shut off steam at boiler valve. Do not use reducing valve for this purpose.

If engines are to be changed, trainmen must satisfy themselves that steam is shut off at engine before uncoupling cars.

In freezing weather, if cars are to be laid up, or stand thirty minutes after engine is uncoupled, the hose throughout the train must be uncoupled, and all drip valves or blow-off valves opened.

The greatest expense of maintenance of steam equipment is the renewal of the coupling hose. The following set of specifications and rules for testing are reasonable, and have been found to give good results. At least one per cent. of each lot of steam hose should be tested:

Samples selected at random from each invoice must deflect 5 inches for each 24-inch length for a pull of not more than any shown in the following table:

Steam at 45 pounds to 60 poundspressure to be on hose 10 hours and off 14 hours of each day.

Maximum allowable pull to deflect 5 inches.

	Before test.		During test of two weeks.	
	Cold.	Hot.	Cold.	Hot.
1¼-inch hose..	45 ounces.	35 ounces.	55 ounces.	45 ounces.
1½-inch hose..	60 ounces.	50 ounces.	75 ounces.	70 ounces.

After the test the tube must be in good condition, and the hose must not have increased in outside diameter more than 10 per cent.

All hose to be smooth, uniform and well finished.

Governor Morton of New York has decided not to approve of the report of the committee recommending the adoption of the Savage gun for the State militia. He exonerates the committee from the charges brought against it by disappointed competitors and states that the report of the committee appears to be unbiased. His decision is based on the ground that the expenditure for the guns ($300,000) is not warranted, as the United States government is contemplating arming all the militia with Springfield rifles. The Governor has also learned that there is some doubt as to a high-grade magazine rifle being necessary for such a body of troops as the State militia.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING...NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

NOVEMBER, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

A noteworthy event in the progress of the horseless carriage is announced in dispatches from London. A company operating nearly 1,000 omnibuses in that city is going, it is said, to put into service in November 100 new motor "buses," in which electricity will take the place of horses. The dispatch says that 300 more motor omnibuses will go into service in January. If this is true—we must admit we doubt it—and the selection of the style of driving machinery is wisely made, the experience gained should go far toward deciding the immediate future of the horseless carriage. If motor omnibuses can be successfully operated in the crowded streets of London, others will have faith to push the development of this type of vehicle.

The labor involved in the preservation of information contained in technical journals is serious enough to make every one who systematically files such data eager to adopt shorter and easier methods. The most novel method we have heard of is that of photographing articles of value and filing the photos. All that is necessary is to have a small camera on your desk, and when an article is to be copied the camera is turned on it, you press the button and 'tis done. This sounds well but unfortunately that is not the end. Visions of a dark room float before us, and we see an individual bending over a developing tray and occasionally cussing at a plate on which a picture will not come, or on which it is so indistinct that he can't tell whether it is that article from the AMERICAN ENGINEER which he wished particularly to save, or a page from "Trilby." This amateur photographer and veteran collector of engineering notes after spending the whole evening in the dark room finally places the good plates in a drying rack and retires to rest in the small hours of the morning. Next day he forgets about his plates and when he does think to examine them he finds most of them were not washed properly and have been ruined by "sweating" The inventory of the first 30 plates exposed reads about like this: Plates with no picture at all, 6; negatives under-developed and illegible, 11; negatives out of focus and useless, 5; plates spoiled in developing, fixing and washing, 4; good plates, 4. After studying this inventory and noting that the four good plates are the least important of the lot, our amateur photographer probably decides that running a camera is not as easy as it looks and he will return to the good old way of filing his notes.

The report that Mr. Yarrow, the well-known shipbuilder on the Thames, England, is contemplating the transfer of his business to the continent, has caused no little stir in the industrial circles of Great Britain. It appears that the labor problem has been the predominant factor in raising the question of removal. *Engineering*, in a leading editorial on the subject, says some things which workmen the world over should take to heart. We quote a few words as follows: "Workingmen are not less interested in the state of affairs revealed by Mr. Yarrow's action than are employers. How are they to protect themselves against the competition of low wages? We do not think that the remedy lies in the reduction of the rate of pay, or even in an increase of the hours of labor. What is wanted is a full recognition of the fact that a good day's work is the complement of a good day's pay. . . . If the leakage that takes place in most works could be avoided, half our commercial difficulties would disappear at once. Trade union delegates are fond of talking about the partnership of capital and labor, and therein lies the kernel of the whole matter. If the workmen would realize that out of every penny lost to the firm, three farthings comes out of their pockets, and would act on that fact, half the danger of foreign competition would be at an end. Idleness, drunkenness, inefficiency, insubordination, and the like have all to be paid for out of the 'wage fund,' and although the money comes through the master's hands, yet in the long run it is paid by the workmen." These are facts which employes should bear in mind constantly, particularly those employed in a country like this, where wages are higher than in other lands. High wages and low cost of production can only go hand in hand when the use of labor-saving machinery is supplemented by good, conscientious work on the part of the men. Dissipation that begins Saturday night and ends Monday noon or Tuesday morning, not only causes a man's wages to rapidly disappear, but it entails loss upon his employer because of the half-filled shop on Monday, the delayed work, and the inefficiency of the man whose mental and physical powers are weakened by such a course. Equally real is the loss arising from indolence in working hours, from bad work, or the waste of supplies, etc. These losses may for a time only operate to increase the cost of the work done, but ultimately they will reduce the wages of the employee, thus placing the loss where it belongs. High wages can be maintained only by a partnership between the employer and the employee, in which the former furnishes the best of facilities in the way of plant, labor-saving devices and competent superintendence, and the employee contributes the best work possible, contributes it regularly, and adopts peaceable methods for settling disagreements between himself and his employer.

OUR CRIPPLED NAVY—WEAKNESS OF ITS PRESENT ORGANIZATION.

The growth of our new navy, as evidenced in its powerful battleships and swift cruisers, is a source of pride to the American people, and it is with much satisfaction that they contemplate the engineering skill exhibited in the design of these vessels. Unquestionably, there is good reason for much of this pride, for not only do the vessels rival those of the most advanced nations in machinery, guns and armor, and in all the essentials of efficient fighting machines, but they have been created by a nation that only a decade ago had no navy worthy of the name and whose magnificent merchant marine of 50 years previous had dwindled to insignificance.

So remarkable has been the growth of our navy that the fleet which is now the pride of the American people is the wonder of other nations. But little more than a decade of modern naval construction has sufficed to bring into prominence the work of American naval engineers and American builders and manufacturers of naval structures and materials.

Some of the greatest advances in the construction of armor are the work of American engineers and manufacturers; the ordnance on our vessels is as good as that possessed by any other nation; the engines that propel them are recognized to be of such excellence that a fleet engineer in the English navy, after saying that his nation had little or nothing to learn from foreign nations about marine machinery, added, "not even from the United States"; the boiler power given these vessels is so abundant that we hear of none of the vexatious failures common in some of the best navies, and the advantage which American men-of-war possess in their ability to run at full speed over long distances without distress to boilers or engines is recognized abroad; our battleships, while not the largest, are noted for the heavy armor and ordnance carried on their displacements; the cruisers *Columbia* and *Minneapolis* are the swiftest war vessels of their type afloat; and in the new armored cruiser *Brooklyn* the United States government possesses another vessel that leads its type in speed. Such achievements as these in a period of little more than ten years, are rightly viewed with pride, although only men like our readers, who have a technical knowledge of engineering and industrial enterprises, can fully realize the extent of the progress made.

It is so pleasant to view this side of our naval growth that it is all the more disappointing to turn our attention to another and more important part of the navy, one which is less creditable to us as a nation. We refer to its personnel. The material side of our navy, represented by its ships and their equipment, is a bright picture, but the personnel presents a picture that though brilliant and attractive in many respects is, nevertheless, sadly stained and discolored. The best interests of the navy require that this picture be studied with care. All that is grand in the modern war vessel has been given general publicity, but exceeding care has been taken that outsiders should not know how inefficient our navy would prove in time of war through the weakness of its organization. The taxpayer is given full opportunity to ascertain the qualities of the ships in which millions are invested, but the fact that these millions of investment are endangered in times of peace and virtually rendered impotent in war by an organization that reduces to the smallest possible number the all-important staff of engineers, is carefully concealed from him. An efficient navy cannot exist without good ships, but neither can it exist without good men, and though both are desirable it is a fact that "good men with poor ships are better than poor men with good ships." But the citizens of this country, ignorant of the true condition of the navy personnel, are to a large extent following in the footsteps of their law-makers and have become so impressed with the ships of the navy as to ignore the necessity of an efficient and united body of officers to command them. Thirty years of comparative neglect of this the greatest source of any navy's strength, has resulted in a condition of affairs in our own navy that is dangerous to the nation and practically sets at naught its investment in ships.

THE PRESENT SITUATION.

Turn from admiration of our ships to inquire into the official personnel and regulations of the navy and what do we find? Officers who should be at peace with one another and united in their efforts to advance the efficiency and effectiveness of the navy, divided into warring camps, the smaller of these camps on the defensive and the larger bent upon the subjugation of the smaller to a condition of humiliation and degradation! We find many true and noble men in all ranks of the service, but we also find abundant evidence of the existence in the larger camp of a class or clique of officers better versed in the business of politics and intrigue than of war, busily engaged in practicing on land the arts of trickery and political wire-pulling while professing to be of the stuff from which the heroes of the sea are made, and guilty of such gross acts of oppression and injustice to their fellow-officers as to make it questionable whether they are not so utterly devoid of patriotism and manliness as to be unfitted to command either in peace or war! We find the engineer officers, the smaller of these warring camps, reduced in numbers until they are not physically able to properly perform all the duties pertaining to their offices, subjected to many petty annoyances, deprived of their rights and humiliated in the eyes of their subordinates! These engineer officers, highly educated, skilled in the sciences and applied mechanics, to whose abilities we owe the existence of our new navy, and without whose services it could not be maintained or its ships operated for a single day, treated by line officers as if they were merely uneducated engine drivers! Line officers can be found assigned to duties for which they are wholly incapacitated by training and education, and drawing salaries for which they give no adequate return to the nation! And the entire service weakened by the intrigues of men who have taken unto themselves powers which are vested in the people and the legislators they have elected, and are using those powers to limit the usefulness of better men than themselves, and to prevent the enlargement and improvement of the engineering branch of the service!

We are perfectly aware that these are severe words, and they would never have been written if there was any hope that reform could come from within the navy; but there is no such hope, and the treatment which the clique of line officers see fit to accord to the engineer officers—and to other line officers who will not bow to them—is so despicable in itself, so unjust to a loyal and honorable branch of the navy, and so injurious to the service, that it calls for action on the part of those who love their country and desire fair treatment for those who serve it, even if a condition of affairs is made public that is humiliating. Our readers have read something of these troubles in the pages of this and other journals, and we trust they will join in the protests that are now coming from many sources, and use their influence to bring about a better state of affairs. They can do this through their Congressmen and through the engineering societies and other organizations of which they are members.

The Wilson-Squire bill, presented before Congress last Spring, will come up again in the next session. It provides remedies for the worst evils in the present organization of the navy personnel, and every section of it can be safely endorsed. Are the thousands of men in the engineering profession in civil life going to lend their influence to bring about a more effici nt organization, and to righting the wrongs of their brother engineers in the navy, or must the naval engineers fight unaided the battle that has been forced upon them by the line officers?

THE STRENGTH OF THE ENGINEER CORPS.

The present condition of affairs is traceable to the introduction of steam propelling power and machinery on board of the modern man-of-war, and to understand the situation it is necessary to go back over a period, which, though short, witnessed prodigious changes in naval construction and warfare. In 1839, or only 57 years ago, the United States did not possess a single war vessel propelled by steam. The commanding officers at that time if skilled in seamanship, navigation and gunnery, possessed all the technical knowledge necessary in their positions. Their successors of the present day constitute what is known as "the line." In 1839 Congress authorized the construction of the first United States war vessel fitted with propelling engines. This boat was the *Princeton*, built upon the plans of Captain John Ericsson. In the same year the construction of two other steamers was authorized, and as there was no established corps of engineers in the navy to design and construct the necessary machinery, the Navy Department appointed the late Charles W. Copeland to superintend this work with the title of "Principal Engineer." With the steam engine came the specialist; engineers had to be obtained to run the engines. It is perhaps not surprising under the circumstances that the engineers should be only warrant officers and were below carpenters and sailmakers in rank, for the importance of the steam propelling machinery was not then realized.

Steam power on war vessels had come to stay, however, and, in 1861, at the opening of the Civil War, the government had in commission 52 sailing ships and 37 steam ships. Comparatively simple and small as was the machinery on board these 37 boats, we find there were 174 naval engineers in the service, while the line officers numbered 671 for the 89 ships of steam and sail.

With the exception of the six years immediately preceding the war nothing had occurred in this period to change the status of the engineers or to make Congress and the country realize the important part they were to play in future naval operations. But during these six years the boiler and engine power in new vessels was increased considerably and there had entered the service a corps of very strong men, nearly all graduates of the Renssalaer Polytechnic Institute. In fact, we had vessels like the *Minnesota* and *Merrimac*, superior to anything possessed by other nations. The status of the engineer had improved to the extent that he was now given "assimilated rank." What fine shade of meaning was conveyed by that term it is difficult to comprehend, but it gave the engineers no power to command and they were considered as non-combatants. We have also seen that in numbers the corps was very small. But the Civil War opened the eyes of every one in the navy to the importance and value of their services, and the needs of the navy compelled a great relative increase in the number of engineers as compared with line officers. The ratio between the two was changed materially. Thus, in 1864, or when the Civil War had placed the navy upon a fighting basis, there were 2,846 line officers and 1,728 engineers, regular and volunteer, in the service. There were in all 617 vessels, steam and sail, and if the sailing vessels are thrown out of consideration there were more engineers than deck officers for the steam vessels. In 1865 the numbers had risen to 2,463 line officers and 2,279 engineers.

In 1866, when the navy had been placed on a peace footing, there were 395 line officers and 379 engineers, thus showing that while in war the force of engineers was of necessity almost as great as that of the line, in times of peace with the experiences of a late war vividly before everybody, the need of an efficient corps of engineers was recognized, and practically the same ratio between the numbers of line and engineer officers maintained as had existed in the war. In that year there were 320 vessels in the navy register, the largest of 5,090 tons (old measurement) and the smallest of 50 tons (old measurement), and though the displacements of all the vessels are not on record, the 121 whose records are available show an aggregate tonnage of 119,561, or an average of less than 1,000 tons. The exact horse-powers are not known, but they averaged from one-quarter to one-third of the displacement, or say about 300 horse-power per vessel. A little calculation will show that the number of line officers was one for about each 800 tons displacement, and that the engineers each looked out for about 300 horse-power of machinery.

The importance of the engineer was now so evident that an intense jealousy sprang up in the line against them, and every means available was employed to keep them down. The result of this jealously of the line is seen in the naval register of Jan. 1, 1886, just before the first vessel of the new navy went into commission. Then we had only 73 steam vessels, which included serviceable vessels, those requiring extensive repairs and others launched but awaiting appropriation to complete them. This number also included 13 tugs, one or two of them useless, and others of but little efficiency. In addition to the steam vessels we had 12 wooden sailing vessels. The displacement of the 73 steam vessels was 132,075 tons. The tonnage of the 12 sailing vessels was 23,586. With the exception of a few vessels which were built of iron, the horse-power of the several ships was about what it was in 1866, since we possessed at that time practically the remnants of the war navy. But on this same date, Jan. 1, 1886, the register shows that we had 733 line officers, and only 221 naval engineers in the service! Eighty-five vessels, 13 of which were steam tugs, and 733 line officers! One line officer for each 212 tons displacement, as against 800 tons 20 years previous! It should be borne in mind that during all this period engines were auxiliary to sails, and the ordnance had not changed materially, so that the duties of line officers required practically the same knowledge as in the beginning of this period. Why, then, this enormous increase in numbers and the decrease in the number of engineers?

Then came the new navy with its absence of sails, its great steel ships, enormous propelling engines, high-power guns and complicated machinery. Our readers need not be told that it is an engineer's work to design all the machinery of such vessels, and to care for and operate that machinery in service. But on Jan. 1, 1896, we had 168 vessels in commission, aggregating 285,466 tons displacement and 317,275 horse-power, 714 line officers and only 173 engineers, or one less engineer than just before the war, when there were only 37 steam ships in commission and not one of them with engines of more than 1,000 horse-power—and less than one-half as many as in 1866. And yet in this period the number of line officers were nearly doubled.

Nor has the status of the engineer improved much during this period. Congress tried to give him the much-needed rank and authority in 1871, but the line had the word "relative" inserted in the bill before the word "rank." This was objected to by several members of Congress, but upon receiving assurances on the floors of both Houses that the word would not abridge the rights and authority of the engineers, it was allowed to remain in the bill that became a law. Once a law, the line snapped their fingers in the faces of the engineers and told them that relative rank was no rank, and that the Congress which had meant to do so much had actually done nothing. This shows the power of being able to interpret a law—a prerogative which is the province of the judiciary, but which has been seized by the sailor officers.

This brief sketch throws a little light on some of the doings which have brought the naval forces to their present status. Loath as one may be to believe that a "machine" exists, does anyone suppose that without undue and baneful influences at work the creation of a new navy of steel ships, involving the highest knowledge of steel construction, steam engineering, electric and hydraulic engineering—all the province of the engineer — would be accompanied by a great increase in a branch of the service that has a superficial, if any, knowledge of these matters, and a decrease in the branch that is expert in them? We might go into many details to show that improper influences have been and are at work, and that the great increase of the line and decrease of the engineer corps was not the result of natural causes, but due to a pernicious activity of a portion of the line, but we deem it more important at this time to exhibit the present weakness of our navy and to state the changes necessary to remove that weakness than to show up the clique that has brought about the existing conditions. Besides, in exposing the weakness of the navy we incidentally air the methods of the "machine."

THE ENGINEERS OVERWORKED.

There are many evidences at hand that the engineer officers are overworked and the safety and efficiency of our magnificent fleet endangered thereby. We have already shown how their ranks have been steadily depleted as the number of modern vessels has increased—a fact which is proof enough in itself. Furthermore, members of the engineer corps are constantly breaking down in health in the discharge of their duties at sea. We can recall many cases already this year, and if we went back over the records the list would be a most formidable one. In our September issue we recorded the breaking down of two engineers on the *Indiana* or one-half of the engineer force on a $5,000,000 ship. A few days ago two engineers on the Asiatic squadron broke down, leaving this squadron on the other side of the globe with a force of 10 engineers only. The reasons for these breakdowns are easy to be found. A vessel goes to sea with such a small complement of engineers that these officials have sometimes to take watches for 12 out of each 24 hours. The vessel has so many line officers on board that these men have known to be on duty only four out of 24 hours. The engineers have direct charge of one or two millions' worth of machinery below decks, and they and their men are working in a temperature of from 150 degrees to 170 degrees. The deck officers navigate the boat and have charge of the men who scrub decks, polish the bright work, and do police duty, and they perform these onerous duties in the fresh, bracing air. Is it any wonder that the engineers break down and that the breaking down of a line officer is unheard of? Chief Engineer Tower, of the *Indiana*, had been on duty continuously for 36 hours when he succumbed to the strain.

To show how short-handed is the engineer force on some of the boats in which the taxpayers have invested millions, let us make a few comparisons. The *Minneapolis*, a 23-knot triple-screw cruiser, 7,375 tons displacement and 21,000 horse-power has 90 separate engines, with a total of 172 steam cylinders. She has at present three engineers and three cadets under instruction. She is supposed to have four engineers, but one of the engineers on the European station recently broke down, and now they are short-handed. The American line steamer *St. Louis* of 16,000 tons displacement has about 20,000 horse-power. We don't know how many separate steam engines are on board, but evidently they are less than on the man-of-war. She has four senior engineers, 15 junior engineers, 2 electric engineers, 2 refrigerating engineers and 1 deck engineer, or a total of 24, to say nothing of 6 cadets.

On the *St. Louis* we find no grade between engineers and the oilers and firemen except two storekeepers. On the *Minneapolis* there are supposed to be six chief machinists at $70 per month, six first-class machinists at $55 and five second-class machinists at $40 per month. When we consider that a man-of-war must be in a large measure independent of docks and repair stations we might well look on these machinists as the repair gang. The chief machinists are supposed, however, to be capable of taking an engine-room watch. The first-class machinists need be only machinists with some knowledge of marine engines and boilers, while the second-class machinists need have no experience at sea whatever, with marine engines. Evidently, if there were six chief machinists capable of standing a watch the situation would still be pretty bad. But so inadequate is the pay and so galling the service in the engine and fire rooms of our men-of-war that the government cannot get men to enlist as chief machinists in sufficient numbers. Men intelligent enough to be trusted alone on an engine-room watch can get better pay on shore. And on shore they don't have to sleep in hammocks spaced in some cases only 13 inches from center to center, and to turn out in the early morning with the deck hands after working nearly all night on repairs or other emergency work. On the *St. Louis* all the junior engineers have bunks and can have undisturbed rest after such duties. It is not so with the chief machinists. What is the result of all this? On the *Minneapolis* there is only one chief machinist! There are 11 first-class and 1 second-class machinist on board. Consequently where the *St. Louis* has an entire engineer force of 30, including cadets, the *Minneapolis* has three engineers and one machinist capable of taking a watch, and three cadets not yet graduated from school, or a total of seven persons, only three of which are worthy of the title of engineers, and really ought to be trusted implicitly with the care of the machinery. On the *Minneapolis*, now in the Mediterranean, the Chief Engineer is probably taking a watch of four hours himself, besides attending to his duties in connection with the supervision of the entire engineering force, the other engineers and the chief machinist are on duty 10 hours out of the 24, and what these men can't oversee of this immense engine, boiler and machine plant, worth more than $1,500,000, is of necessity intrusted to machinists paid $55 or $40 per month!

Another startling condition of affairs is found in the firerooms. These are in the immediate charge of the water tenders paid $40 per month. It must be borne in mind that these boilers are in several compartments separated by bulkheads in which all doors are closed when the ship is underway. Here are, say, 21,000 horse-power of steam generators with feed pumps, ash hoists, bilge pumps, etc., etc., under the charge of $40 per month men. The engineers on watch can give but little attention to the fire room with their present numbers. The line believe that there should be a commissioned officer on deck for every small gun carried. Why should there not be a commissioned engineer officer at all times in every one of the six compartments containing the propelling machinery? Would not the safety of the vessel be promoted thereby and the expense of maintaining its machinery be reduced by such complete and intelligent supervision? The highest naval authorities are agreed that the salaries of these additional officers would be more than saved by the reduced repairs. We would point out that these additional salaries in the engineer staff could be provided for by reducing the number of line officers, of which the *Minneapolis* carries nine, besides four cadets.

It is proper to note that the pay of machinists in the navy and their duties are decided, not by the engineer officers, but by the Bureau of Navigation. To read the schedule of pay and duties will convince any intelligent reader that they were never prepared by men familiar with the requirements of the engine room force on board ship.

In the British navy there are 1,739 line officers and 795 engineers—a ratio of 2.18 to 1. In our navy, as already stated, there are 714 line officers and 173 engineers—a ratio of 4.13 to 1. Thus we have relatively only one-half as many engineers as in the English navy; and it should be borne in mind that great pressure is now being exerted in favor of an increase in the number of English naval engineers because of the inadequacy of the present force.

If any further testimony of the overworked condition of the engineers is needed it can be found in the report of the Surgeon-General of the Navy for 1895, where he calls attention to this fact in words that leave no room for doubt.

EXCESSIVE NUMBER OF THE LINE OFFICERS.

There is, therefore, no escape from the conclusion that the engineer corps is in numbers far below what is necessary to operate and properly maintain our ships. The zeal and ability of the 173 on whom the duties fall have prevented until recently a full realization of the actual situation. But though the engineer corps is so small as to make it impossible to perform certain shore duties in connection with the building of new vessels and the repairs of old ones, there is no shortage in the "line." Out of a total of 714 officers, there were, Jan. 1, 1896, only 338 attached to vessels at sea. Of the 376 on shore, 91 were on duty at Washington; nine were running a war college that holds sessions in the summer months only, and whose average attendance is about 25; 51 officers were running a naval academy at which there are only 241 cadets in attendance; at Newport there are, in addition to the 9 officers at the war college, 12 at the training ship and torpedo station, but not one engineer: at the Boston Navy Yard there are 8 line officers and only 2 engineers; at Mare Island there are at the receiving ship and navy yard 13 line officers and 7 engineers: at New York there are altogether 23 line officers and 17 engineers. But perhaps the inspection of steel furnishes the most surprising examples of the employment of line officers to the exclusion of engineers. The steel board is composed of two line officers and one engineer. The inspection of steel and armor is performed by 6 line officers, 2 engineers, 1 carpenter and 2 sailmakers! The inspection for the Bureau of Ordinance is done by 6 line officers. So that out of the 20 officials concerned in the steel inspection there are 3 engineer officers, or the same representation as is given the carpenters and sailmakers! Is any comment necessary?

THE STATUS OF THE ENGINEER.

Essential to the efficiency of the service as is an increase in the number of engineer officers, a better official status which will make the organization attractive to scientific experts is equally so. At present, the naval engineer is denominated a civil officer, although exposed to as great danger as the man protected by the walls of the conning tower. He is termed an "adjunct," "auxiliary," "noncombatant," and the watch bills of some of our warships will show that he is also officially designated as an "idler." He is given what is termed "relative" rank, but when the fact is comprehended that he is not officially regarded as a military officer it is unnecessary to state how discredited and unsatisfactory the possession of relative rank is. By reason of not possessing military rank he is subject to the beck and call of numerous underlings claiming to be invested with the prerogatives of the commander. As Professor Hollis has epigrammatically said, the conferring of relative rank simply permits the Department "to fix precedence so that there be no dispute about the order in which officers select their rooms on board ships, march in funeral processions, approach and bow before the President at a New Year's reception, or sign their names on official papers."

The status of the naval engineer will not be properly recognized until he is given absolute military rank, for the line have never recognized the possession of relative rank by the engineers as giving the corps a military status in the service. The spirit of this contention has been expressed by one line advocate in these words: "Equality with line officers is simply absurd. You may depend upon it that any amount of money and political influence will be forthcoming at the proper time, if necessary, to resist the unparalleled impudence and assumption of the subordinate branch of the navy to the honors and dignities of the line."

The engineer officer on board ship thus finds himself in a discredited position, where he is unable to carry on his work to the best interest of the nation. He is nominally "in charge" of the entire engine-room and fireroom force, but a deck officer who is his junior may assume prerogatives which will demoralize and disintegrate an organization which the engineer has been perfecting for months. Even when the commander is within speaking distance of the officer of the deck the subordinate line officer claims to be in charge of the ship, and the line even goes so far as to maintain that the naval cadet who is on probation when temporarily in charge of the deck can presume to assert such authority over the engineer and his department, A fitting *finale* to such an organization is a corps of prostrated engineers, a fleet of ships which are inefficient, and a service that is badly crippled for the work of war. Surely its weakness only needs to be pointed out to have Congress effect radical reform.

It is not surprising that with a powerful "machine" in existence, and with the engineer corps without proper status, justice should miscarry in many courts-martial, the favorites being protected and others unduly punished. Mr. Mattice, formerly of the naval service and now a distinguished consulting engineer, gives a summary of many courts-martial; we cannot go into the figures at length,* but the navy records show that two trials of line officers for cowardice resulted in the offenders receiving sentences aggregating three years of suspension, and a total loss of six months' pay; of twelve cases where ships were lost apparently through the fault of line officers, seven cases were never brought to trial, and in four cases the suspensions aggregated 9½ years, or an average of only 14¼ months for each officer implicated, all suspended officers being paid from three-fourths to full pay during the periods of their punishments, while in the twelfth case the commander was dismissed from the service, as it was shown that he was intoxicated at the time his vessel was lost; in six cases of vessels aground, four were never tried and the other two resulted in nine and ten months' suspensions respectively for the captains; a serious damage to a ship in docking was punished by six months' suspension of a line officer; drunkenness on duty, two months' suspension. In all of these cases the parties were in the pay of the government during the suspension, often under full pay, except where we have noticed to the contrary. But a past assistant engineer a year or more ago was tried for being absent without leave while his ship was tied to the wharf of a navy yard and he was sentenced to one year's suspension on furlough pay (one-half of "waiting orders" pay) and to lose all promotions in that period, which resulted in his losing ten numbers on the list in his grade. Other cases of equal discrimination could be cited. Admirals too honorable to toady to the "machine" and secretaries of the navy have remonstrated in vain at the inadequacy of the punishments meted out to line officers and have set aside as perversions of justice many of the sentences against engineers. The daily papers recorded such a case only last month. Any intelligent person can realize that such discrimination between line and staff officers fosters a spirit of bitterness between officers and men alike, and that the unjust treatment of engineers in courts-martial and in all matters involving authority and discipline is resented by the entire engine and fire room force of enlisted men. These men are often badly treated themselves by the deck officers and they know by bitter experience their own officers are helpless and that they can turn to no one who understands them and their work.

Shore duties also furnish several good illustrations of the evils arising from this lack of authority in the engineers, one of which is found in the inspection of steel already noted. If any private concern bought hundreds of tons of steel at a cost of $500 per ton it would exercise every care to see that the material was properly inspected, but the armor for the navy is inspected by line officers who certainly cannot be expected to know as much about steel as the engineer. How was it possible for the armor frauds of several years ago to be perpetrated upon the government if the inspectors were capable? Why were these frauds hushed up? Would they have been hushed up if the inspectors had been engineer officers? As another illustration, turn to our navy-yards and arsenals. Here we find these great building and repair establishments under the control of line officers and so firmly in the grip of military rule as to make the time required and the cost of the work done by them much greater than the best authorities believe would be required under a supervision of trained engineers. Would any private manufacturing establishment place millions of capital and a working force whose pay roll aggregates many tens of thousands per month under the control of men not trained in engineering or of engineers with limited authority?

Even the design of our ships are not free from these influences. Some of our great battleships might be faster than they are if the bureaus of steam engineering and construction could get an unprejudiced hearing for their opinions. The electric plants on these vessels have been taken from the control of the engineers and operated by the line until they break down, when the former are sent for to repair them. These plants must now be located to suit the convenience of the line officers, regardless of whether such locations are the best. Nay, more; the steam pipe running to the dynamo engines must not take steam from any steam main, but must tap the boiler itself. An extra hole must be made in the boiler and a hundred feet of extra steam piping, more or less, must be provided to give to the electric plant of the "line" the necessary isolation from the domain of the engine-drivers! The naval attaches in foreign countries are maintained

* We would refer our readers to Mr. Mattice's open letter, "Queer Doings in the Navy," and to a valuable article by Mr. Wm. Ledyard Cathcart in *Cassier's Magazine* for October.

in those positions chiefly for the engineering information they can pick up for the department at home. Of course they are engineers. Nothing of the kind. They are line officers without training for such duties. The country no doubt will be amazed to learn that the education of these line officers, preparing them for the most desirable duty of naval attaché abroad, is accomplished in 10 or 14 days. Previous to taking their departure for Europe to perform the engineering duties required of a naval attaché, they receive a roving commission to visit the largest engineering establishments in this country. The very fact that they undertake to study American methods in 10 or 14 days shows their absolute incompetency for the work. The only advantage they derive from this tour of inspection is that they receive eight cents a mile while making a pleasant excursion at the expense of Uncle Sam.

It was through one of these brilliant attachés that the government spent a large sum for the purchase of plans in England for the *Charleston*. In a discussion before the Engineering Congress at the World's Fair, Mr. Mattice gave some information about these plans that shows how competent was the attaché. The plans were supposed to be those of the *Naniwa-Kan*, but the general plans were those of the *Etna*, and the details were of the *Naniwa-Kan* and *Giovanni Bausan*, "and there were one or two of a rather chestnutty flavor that would not fit in with anything else." The Secretary of the Navy ordered these plans to be followed closely, and as a result costly changes had to be made as the work progressed, and the vacuum pumps had to be discarded and new ones built at a cost to the government of $50,000. Another set of plans purchased in England were not quite so bad, but many changes were made in them by the bureaus of steam engineering and construction before the *Baltimore* was built from them.

THE OPPOSITION OF THE "MACHINE."

The machine fights tooth and nail the proposition to improve the number and status of the engineers, and insists that any increased authority given them will demoralize the service. They charge the engineers with a desire to get everything in their power. As this article is in course of preparation, there comes to our desk a copy of the *Army and Navy Journal* for Oct. 3, containing an article written by a line officer. In this article he says: "The engineer feels that since modern vessels depend entirely upon steam for ability to use their guns, and since engines depend on trained knowledge, and since he must undergo danger without the line officer's privilege of striking back, *he should have the best of everything*. It is suggested that the naval engineer is on a plane with the scientific army engineer, and it is proposed *to make the naval engineer the leading officer of the navy*. They forget that their basis is engine-drivers." The italics are ours. The supposed claims they emphasize are fictitious and false. The engineer does not ask for the command of vessels, but he does believe that the good of the service and his own honor alike demand that he be under the authority of the commanding officer of the vessel and not at the beck and call of every officer of the deck, even an ensign. He does believe that the good of his branch of the service demands that his present "ralative rank," which is title without authority, be changed to a positive rank by which his titles will mean something. He does believe that the deception now practised upon the people of the nation, by which engineer officers appear in civil life and on state occasions with the honors of their titles, but on board ship are stripped of it all, is a farce that endangers discipline and engenders discontent and strife among the entire crew.

But the line officer we have quoted above is really anxious about the engineer. Hear him again: "The engineers want too much, but that is no reason why they should not have justice. *Let us do justice.*" Need we go any further for evidences of a clique? Has it come to this that the line officers announce to this nation that through the line, if at all, justice is to be meted out to the engineers? We admit that proposed changes in the navy affecting the authority of officers might properly originate with the line in which the right of supreme command is vested, but there is little hope that they will. We quote again: "The line is the corps of command, and must be. Nothing the engineers may do can alter that. . . . When the engineers recognize that command is essential and must go to the line, then it will be possible to institute a new plan that will give them justice. If they can once see that *the corps of command is the navy*, a reform can be made that will give them a share of the honors of war. I suspect that the real bitterness of the engineer's fight has lain in the feeling that he belonged to a body of men who are expected to do the dirty work, accept danger in the dark and get none of the credit of success."

The corps of command is *the* navy! This is on a par with the insolence of the line officer who told an engineer that be (the engineer) was *in* the navy but not *of* the navy. The engineers, a body of men who are "expected to do the dirty work, accept danger in the dark and get none of the credit of success"? Who expects them to do this? The line officers may, but does the nation? The real bitterness of the engineers' fight has lain in the fact that he knew the nation thought he was getting his due credit, whereas it was being systematically withheld from him. But the last quotation relieves us of the necessity of proving that engineers are unjustly treated under the present order of things, for this line officer expressly admits that they are.

HOW A NAVAL RESERVE CAN BE OBTAINED.

Then both justice and the immediate needs of the service make it imperative that the engineer corps be increased in numbers and that the engineers be given rank equal to their confreres in the line and an authority that will make that rank respected. But another and an equally good reason exists for raising the status of the engineer. If the number of engineers is to be increased and an adequate reserve is ever to be provided for the time of war, inducements must be offered to get men for the service. They will not enter it in sufficient numbers under the present conditions. The engineers already in the navy would resign from it with little delay, did not loyalty to their country and the hope of finally receiving justice from her hand keep them in her service. Even as it is resignations have been numerous, and the number of engineers graduating annually from the naval academy is not sufficient to balance the loss from breakdowns, deaths and other causes. If honorable positions in the navy are with in the reach of graduates of our technical schools and colleges, many will avail themselves of the opportunity—but not until the engineer is accorded justice. And if war should ever come, ex-naval engineers and others in private life will not offer their services to their country—where such services involve a degradation. It may be argued that loyalty should bring the engineers into their country's service in time of dire need, regardless of questions of rank and title. It should not be forgotten, however, that the greatest of patriots are always the manliest of men, and that a nation which wants the services of noble men in time of war should not neglect the present opportunity to make that service an honorable one.

The engineering profession of the United States have pointed out the naval weakness to Congress and the people, but they have done more than that—they have shown what remedies should be applied. The Wilson-Squire bill, already mentioned, introduced in the House by the Hon. Francis H. Wilson, of Brooklyn, N. Y., should be the basis for all naval legislation enacted for the personnel. If the engineering profession will continue to display its interest in this bill, Congress can be made to realize the crippled condition of the navy, and the bill thus become a law.

TESTING CAST-IRON CAR WHEELS.

In one of the earlier articles on the Altoona shops, which appeared in these pages, an account was given of a method of testing car wheels by pouring molten cast-iron around the treads, the wheels being laid in the mold with their backs or flanges down. As was then described, a sand mold is made around the tread of the wheel which leaves a space of about 2 inches wide between the sand and the tread. Melted iron is then poured into this space. Most of the wheels that have been tested in this way, it was found, broke or cracked in from 25 seconds to 1¼ minutes from the time the metal was poured. The inference from this was that if wheels are broken by heating them in this way they will also be broken by the heating action of brakeshoes when these are applied, especially at high speeds.

It may be said here, incidentally, that mankind may be roughly divided into two classes, one composed of people disposed to entertain new ideas, and the other of those who are not, many of whom have a positive disinclination to give consideration to any subject, or credence to any facts, or accept any process of reasoning, of a kind with which they are not familiar. Many such people, too, are born objectors, and are possessed of a wonderful capacity for finding reasons why things are not so. They are like the lawyer who was consulted in that well-known case of the prisoner who was incarcerated for a certain offense, and who was told by his legal adviser that a person could not be put in jail for the act of which the prisoner had been guilty. "But I am locked up," the client pleaded, but that fact would not change the opinion of the lawyer.

With the class of people referred to facts have no more weight than the lawyer was willing to assign to the curtailment of his client's liberty. It is in vain, in arguing with such people, to bring incontrovertible evidence to establish certain facts. They are deficient in the capacity of believing, which the Scriptures teach is a means of salvation and assure us that neither would such people believe although one rose from the dead.

This digression was suggested by the way in which the account of the thermal tests of wheels at Altoona, which was published in these pages some months ago, was received by some of the readers of the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL. One correspondent said the test was "sensational." Others said it was not new and some of the wheel-makers thought it was not fair. All admitted that car-wheels are often heated by the application of brakes, but then they say they do not get "so very hot," or they are not heated so quickly by the brakeshoes as they are by the melted iron poured around them. Now as a matter of fact no one knows with any degree of certainity how hot a wheel gets when brakes are applied on a car. One case is reported of a wheel, broken in service, which was so hot an hour after the accident that it could not be touched without burning the toucher. Imagination only can infer how hot it was when broken. As a matter of fact wheels are not "very hot" when they break under a thermal test. They often crack within 25 seconds or less time after the pouring of the metal. Not a very high degree of heat can be transferred to a wheel in that time. Who knows how quickly or to what degree a wheel will be heated if an "emergency" application of the brakes is made when running at the rate of 60 or 70 miles per hour?

Another resource of the doubters is that any innovation in their experience or practice is not new. Even if it is not, the *utility* of it is not affected thereby. Would a reasonable human being object to using any useful information, even if it was exhumed from the catacombs, or dug up from the foundations of the pyramids, and was as old as Egyptian civilization. Wisdom and knowledge don't deteriorate by age if they are really either wise or true.

Some of our readers who are inclined to *dubiosity*—if there is such a word—say that the thermal test is not a practically fair one, and is calculated to unduly alarm the traveling public. Nevertheless, the Pennsylvania Railroad officials at Altoona have been developing the test, and have reached the conclusion that in specifications for wheels which they buy that a certain number in each lot received shall be subjected to a test of this kind, and if they do not stand it all are to be condemned. An extensive series of investigations were made before this conclusion was reached. More than 200 wheels were tested, of which a large proportion—about nine-tenths—were broken or cracked. The fractures were very curious. In a large number they occurred just inside of the rim and extended circumferentially for a distance varying from a fifth to a third of the way around. In some cases the wheel was merely cracked, the fracture not extending through the rim, but in others the rim was broken radially to the circumferential crack, and a piece was entirely detached from the body of the wheel. In others the break would be on a line approximating to a chord drawn to the periphery of the rim or tread. Another form of break was on a circumferential line, about half way between the hub and rim, or where the double plates join the single one outside of them. (Nearly all the wheels tested were of the Washburn, so called, double plate pattern.) These cracks also extended from a fifth to a third of the way around, and were sometimes confined to a circumferential line and in others would extend radially from one or both ends out to or through the rim. In some instances these fractures were mere cracks, while in others a piece was bodily detached from the wheel. Often the break occurred before the molten iron had solidified, and with such violence that it was scattered out of the mold in a way that was dangerous to the bystanders. Another curious phenomenon was the fact that often a secondary fraction would occur after the first one and on the opposite side of the wheel. The two would not always occur at the same part of the wheel section nor in the same form. Some or all of the brackets or ribs were broken in nearly or quite all the tests even when the plates were not fractured. Mr. McLean, the superintendent of the foundry, who made these tests, obtained five double-plate wheels of the old pattern made by the Lobdell Company in Wilmington, Del. What is called the Washburn double-plate wheel, which is the pattern now in general use, has not in reality double plates, as the two plates extend only about half way from the hub toward the rim, and there they unite in one plate which extends to the rim. The Lobdell however, has two full plates, which extend all the way from the hub to the rim with a space of from about 4 to 6 inches in width between them. The plates are slightly curved. None of these wheels broke into pieces; several of the outside plates developed short circumferential cracks, which did not destroy the integrity or the wholeness of the wheel, and it was only the outside plate which was fractured. Altogether they stood better than any other form that was subjected to the test. It would be curious if it should be found advisable to revert to this old pattern of wheel, which was abandoned twenty-five years ago or more—or to something similar to it. This form is to be subjected to a thorough series of tests to ascertain what its real merits are.

Another fact which was ascertained was that wheels which had been in service, or second-hand wheels, did not stand the test as well as new ones. This is contrary to Mr. Outerbridge's theory that cast iron grows stronger if subjected to frequent concussions. Of course it may be that the endurance of these double-plate wheels was due to the quality of the metal in them. It is intended in the investigation which will be made to ascertain how they will act if made of the same material as the wheels which fail. Altogether the Altoona wheels have stood the tests better than any others, excepting the double-plate Lobdell pattern. Some of the Altoona wheels were broken, but many of them stood the test without fracture. It is proposed hereafter to take three wheels from every hundred, and subject one to a drop test and two to a thermal test by making a mould 1½ inches wide around the tread and then pouring iron into it, these wheels to stand two minutes without breaking. The time and the space may possibly be modified if experience shows that it is essential. The adoption of these requirements is quite certain to lead to efforts on the part of wheel-makers to devise forms which will resist thermal strains more successfully than the so-called double-plate Washburn pattern will or does. It may be added that although nearly all the wheels tested were of that pattern, their forms, and especially that of the sets or brackets, varied considerably. The forms of this pattern of wheel which were tested seemed to have little influence in their capacity to resist the expansion of their treads by heat. As was pointed out in these pages before, the strain required to fracture a wheel, even if made of poor material, must be enormous. The area of the fractured section was often as much as 25 square inches. The force required to pull this asunder can readily be calculated. The new requirement of the Pennsylvania Railroad is likely to mark a new era in the manufacture of cast-iron wheels and must lead the makers either to use better material in them or devise new forms which will resist the new test, even if made of inferior iron.

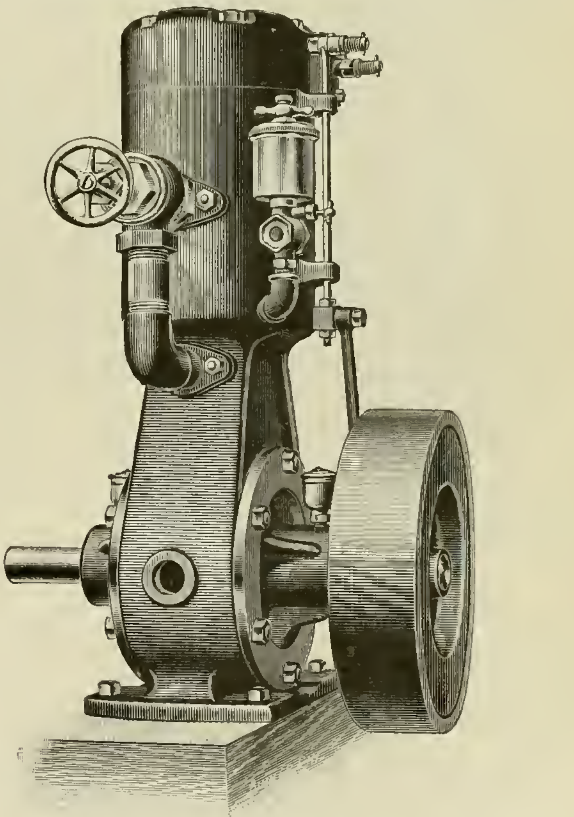
THE PROSPECTS FOR ELECTRICITY ON STEAM ROADS.

Progressive railroad officials, particularly those who are in a position to feel keenly the competition of the electric motor in suburban traffic. are fully alive to the progress and improvements in electric-power installations, and will not be slow to utilize this modern method of power transmission—for that is all that electricity is in its present uses in power plants—when it is possible to effect a saving by so doing, but we think few of them will join with the author of the paper on the "Motive Power of the Future," read before the recent meeting of the American Society of Railroad Superintendents, when that writer says: "We have arrived at a very interesting point in the evolution of railway motive power, a point of transition from old methods to new ones. a point from which it seems possible to almost certainly predict the entire change from steam to a more economical motive agent. . . . Unless, then, we make the assumption that we have reached the end of progressive development, we must admit the very great probability of the entire supersession of steam by electricity as a motive power on our railways, not only in suburban and interurban traffic, but in cross-country traffic also. Primarily, such change will take place because the perfection of economy has probably already been reached with regard to the application of steam." Nor do we think that those who are most directly concerned in the economical operation of the locomotive will agree with the opinion that the limit of possible economy has been reached in present practice. For some years past the economies sought in locomotive design have chiefly been those obtainable by a reduction of the total train expenses, rather than in the economy of the locomotive itself. As a result we have larger locomotives, heavier trains, engines that stay out of the shop longer—or make a greater mileage between shoppings—in fact, anything and everything in design and method of operation that will give the best net result on the capital invested and which will cut down the expenses per ton-mile. When all that can be has been achieved in this direction attention must then be given to the performance of the locomotive as a machine in itself to reduce to the lowest limits its coal consumption for a given duty; then, and not until then, will the l comotive reach its highest efficiency. The electric locomotive has made rapid strides in the last few years, but its best informed friends admit that under the present conditions it cannot compete with the steam locomotive for cross-country traffic. It is believed by many, however, that the developments in electricity in the near future will be of such a radical character that the cost of power in this form will be greatly reduced. If such a sweeping reduction in cost is effected there is hardly any question but that the steam locomotive will be left behind in the race. The economies which it is possible to effect in the operation of our much-respected friend, the steam engine, are considerable, but they are not extensive enough to be entitled to the term "sweeping." On the other hand the radical or sweeping changes in electric motive power necessary to permit it to take the place of the steam locomotive have not yet been made, nor is it clear that they are actually forthcoming. Many are deceived by the comparative youthfulness of electrical science into the belief that our knowledge of electricity is very incomplete and that remarkable developments may be expected at any time and from almost any direction. This is far from the truth. The discoveries in electricity came to a world of science capable of grasping their importance at once, and of pushing forward the work of investigation; they also came to an industrial world equipped with the knowledge and tools necessary for the construction of the new machinery, and the engineering ability to adapt this machinery to the wants of mankind. The result has been the development of electrical science and electrical industries with astonishing rapidity, until to-day they compare with many older sciences and industries in completeness. For these reasons it does not appear that there is, after all, so much to be expected from the further developments in electrical engineering.

Since the above was written, Dr. Chas. E. Emery has presented an excellent paper before the American Society of Electrical Engineers, in which he compares the present cost of operating a heavy trunk line with the expense of the same service by electricity. He shows that the fuel bill is only ten per cent. of the total expense of operation so that a performance at the central station of one horse-power for only two pounds of coal will result in a saving in operation of only 6.56 per cent. of the total expense after deducting the losses of transmission, etc. He concludes that there would be no saving in labor, none in repairs, and none in track maintenance. Furthermore, he shows that the great cost of the electric equipment will increase the fixed charges to such an extent that with money at 5 per cent. interest. the traffic income must be increased 12¾ per cent. to pay these charges. He argues that the use of electricity in suburban travel increases the business of the road for reasons which are already familiar to our readers, but he also points out that in long-distance traffic an increase of traffic due to the electric power cannot be expected. Others supported these views in the discussion and we may safely conclude that the electricians who best understand the traffic of steam roads are the least hopeful of the immediate use of electricity in that service. We shall again refer to Mr. Emery's paper and the discussion on it next month.

A New Naphtha Engine.

This engine, shown in the perspective in the accompanying engraving, presents some entirely new features in a boat engine, which render it especially desirable as a motive power for small boats and launches. It is built by Chas. P. Willard & Company, of



A New Naphtha Engine.

Chicago, which company owns the patents covering the special features.

Heretofore, we believe, all naphtha launches have required the presence of a flame burning in the generator while it was in operation, to vaporize the naphtha, and also required the presence of several gallons of naphtha in the boat at all times. By the entirely different system upon which this engine operates, there is no fire in the boat whatever.

The engine is of the ordinary trunk piston type and the valve mechanism is of the simplest kind, consisting of a single eccentric working a lever operating two cams. There are no gears whatever.

When the engine is first started naphtha is vaporized to obtain an explosive mixture for the cylinder, but after a few minutes the engine is supplied with gas from a patented generator, which is not shown in the illustration. From this generator the gas enters the base of the engine at a point opposite the hole seen in the engraving. Through this hole air is admitted to the base, and the mixture, being slightly compressed by the downward stroke of the piston, passes through a throttle valve into the cylinder, where, after further compression, it is ignited by an electric spark.

One of the valuable features of the engine is its ability to use the lowest and cheapest grades of naphtha and gasoline on the market. There is also no flame in the boat outside of the engine cylinder. The engine can be operated at all speeds and in either direction. The amount of naphtha which is needed on the boat at any one time is much less than where it is used both as fuel and as a working vapor, and, as already stated, the oil can be of a low grade, say a 57-degree naphtha.

The builders, Chas. P. Willard & Company, are located at 197 South Canal street, Chicago, and will be pleased to furnish additional information. The engines are sold complete, ready to put into a boat, or boats complete and ready for operation will be furnished by the manufacturers.

A Device for Centering Cylinders.

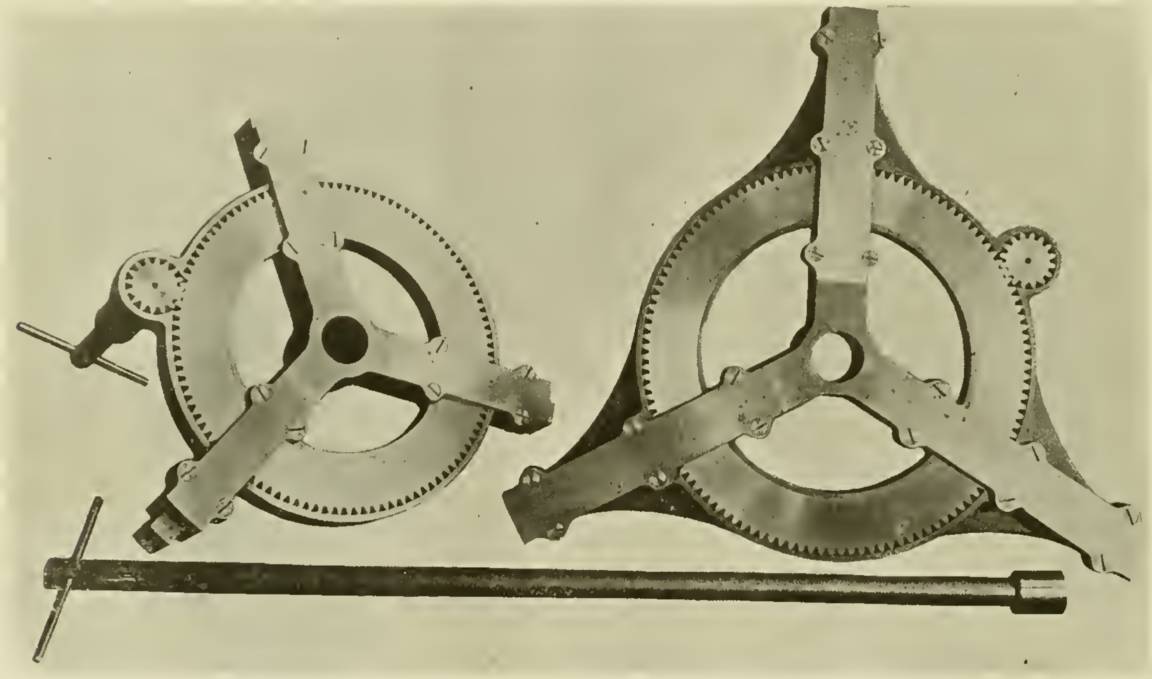
Those who have much to do with the erecting of locomotives or with repairing them will appreciate the neat device for lining up cylinders and guides which we show herewith. It is the idea of Mr. Pedrick, of the Pedrick & Ayer Company, of Philadelphia, and was made by him in response to a request for something of the kind for use in the erecting shop of the new locomotive works in Russia. It consists of a cast-iron spider or frame provided with three steel "jaws" operated in unison similar to the jaws of a universal chuck. Two pairs of spiders were made for the Russian locomotive works, one set for the high-pressure and the other for the low-pressure cylinders of compound locomotives. They are both shown in our engraving.

The steel jaws are neatly fitted into radial channels planed in the spider and are ⅝ by 1¼ inches in section. Their ends are enlarged to give a bearing face 2 by 1¼ inches by an L-shaped extension of the jaws. On the face of these jaws rack teeth are cut to engage a spiral cut on the back of the large ring gear seen in the engraving. The jaws are held in place by plates which cover them and extend across the gear also. A small pinion held in the spider frame meshes into the large gear and, by means of a socket wrench on its spindle, the jaws are set out against the cylinder walls. A two-inch hole through the center of the spider is for the insertion of a turned bar or arbor which is thus held exactly central in the cylinder, and by which the guides are lined up.

It will be seen that the mechanism does away with the labor of adjusting a line or arbor to a central position in the cylinder. All that is necessary is to place the spiders in position, set out the jaws simultaneously and then insert the arbor. The latter is then located centrally and with greater accuracy than is ordinarily obtained.

The larger of the two devices shown is 28 inches in diameter and will fit cylinders from 28 to 31 inches in diameter. The smaller one is suitable for cylinders from 19 to 22 inches in diameter. As each pattern can be given a range of at least three inches, two sizes would suffice for the average railroad shop.

The device has been praised so highly by those who have seen it that the company will add it to its line of manufactured products and is prepared to furnish it in any size required. The workmanship is of the best.

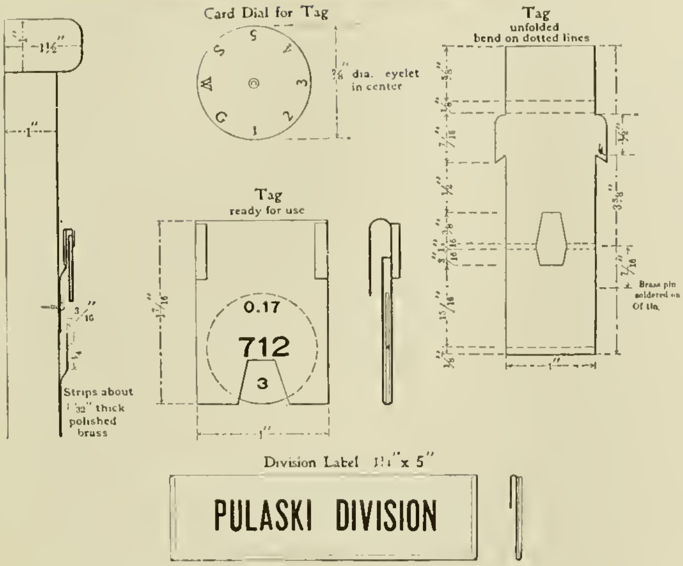


A Device for Centering Cylinders.—Made by Pederick & Ayer Co., Philadelphia.

Norfolk & Western Engine Board.

In the latest number of the proceedings of the Southern and Southwestern Railway Club we find an article describing the engine boards of the Norfolk & Western road, by R. P. C. Sanderson. These boards are believed to fulfill all requirements and are easily and cheaply made. Referring to the engraving it will be noticed that the engine board itself consists of a plain pine or poplar board (shown in section), on to the face of which are secured by screws a succession of horizontal thin metal strips (brass, Russia iron, or something similar). The shape of these metal strips is shown by the drawing, and when in place they form a succession of horizontal grooves. The headings, names of divisions and shops are indicated by cardboard labels, slipped into the label holders, which are simply hung on the metal strips at convenient positions, and can be changed ad libitum to suit changing conditions, by shifting them about, taking them off, or changing the cards in the label holders. The label holders for the names of divisions are 1¼ by 6 inches and a sample one is shown. The shop tags are 3⅜ inches by 5 inches.

The engines are represented by tags of a peculiar form, as shown by the drawing. The tag is made of a sheet of tin, of the



Details of Norfolk & Western Engine Board.

shape shown, which has a small piece of brass wire soldered to it to form a center for the cardboard dial. The dial is also shown separately, and the printing on it can be varied to suit the different requirements. In the case of the dials shown the marking has the following meaning :

1. Repairs required—No. 1—which means general rebuilding.
2. " " " 2—which means new firebox and general overhauling.
3. Repairs required—No. 3—which means general overhauling, with heavy renewals of worn-out parts.
4. Repairs required—No. 4—which means light general overhauling.
5. Repairs required—No. 5—which means light repairs, such as can be done in four or five days without removing wheels.

S. Repairs required—Special—which means such as broken frame, broken wheel, 50 flues, etc.

W. Repairs required—Wrecked—only used in case of heavy wreck damage.

G. Means in good or fair order, in condition to render efficient service, and requiring nothing but current maintenance and running repairs.

After the tin is cut, the center pin soldered on, the dial is dropped on to the center pin, and the tag folded over to the shape as shown on the drawing of the completed tag. The notch or gap in the tag allows one of the figures or letters mentioned above as indicating the condition of the engine to show, as the condition changes, the dial can be quickly rotated so as to show the letter or figure representing the changed condition. Above the notch or gap in the tag is painted the engine number and the class letter or mark. Above the number and class letter is a little pocket formed when folding the tin which is used to hold small labels, either to represent the class of service of an engine in service, such as passenger (through or local); freight (through or local); pushing or helping, shifting, maintenance of way, extra or reserve, etc. In case of engine out of service in the shops, a small card label, as shown, is slipped into this pocket to show what division the engine was in service on before she was shopped.

The board in the office of the superintendent of motive power is 3 feet 7 inches deep and 6 feet wide, and gives the location, service and condition of all engines on the road. In the offices of the various master mechanics are smaller boards of similar design, giving records for their divisions only.

Notes.

The East River Bridge Commission last month received the formal approval of the bridge plans from the Secretary of War. They also entered into a contract with F. W. Miller for the borings necessary for the New York anchorages, the price being 40 cents per lineal foot.

A motor vehicle race took place last week between Paris and Marseilles and return. The distance is 1,051 miles and the first vehicle to arrive was the Michelin motor cycle, which made the trip in 72 hours, including all stops, or at the average rate of 14.6 miles per hour.

The Pennsylvania Railroad considers the outlook so good for business after election that it has ordered all idle freight cars to be put in readiness for use on short notice. In August the number of cars passing through the Harrisburg yards is given as 62,666; in September, 73,303, and October figures show a still greater increase.

The first of the three torpedo boats which the Columbian Iron Works, of Baltimore, is building for the United States government, was launched on October 1. This boat is 160 feet long on the water line, 16 feet beam, and 138 tons displacement. The engines are triple expansion and drive twin screws. Their horse-power is to be 2,000. The contract calls for a speed of 24½ knots.

One of the twin-screw steel ferryboats for use on the Pennsylvania Railroad's new Twenty-third street ferry across the Hudson was launched at Cramp's shipyard on Oct. 17. The boat is to be called the *Pittsburgh*, and a sister ship, being built by Charles Hillman & Co., Philadelphia, is to be called *St. Louis*. The boats have been described in these columns. The chief novelty about them is the use of twin screws at each end of the boat, or four screws in all.

The Pacific Coast may soon have a new and regular source of fuel supply. An American bark recently arrived at San Francisco with a sample cargo of coal from the Tonquin District of China. The coal beds are said to be extensive, and it is also claimed that with the cheap Chinese labor available and the present tariff rates, the coal can successfully compete with the other fuels in the market on the Pacific Coast, providing the quality of the coal is satisfactory.

In a paper before the British Association Mr. E. W. Anderson relates his experience for eight years with an electric traveling crane and a steam traveling crane working side by side in a foundry. The electric crane has one motor, geared to furnish power for all three motions required, and is of 20 tons capacity. When first installed there was a prejudice against it, but now it is the favorite with the men. The repairs to the electric crane have cost less than in the case of the steam crane and in many ways the former has proved more convenient.

The great engineering work of removing the obstruction in the Danube River, known as the Iron Gates, between Alt-Orsova in Hungary and Gladova, in Servia, has been accomplished and the river opened to navigation Sept. 27. The passage of the Iron Gates has always been dangerous and much of the time wholly impracticable to vessels drawing 5 feet of water, because of the rocks and the rapids they created. Enormous quantities of rock have been removed and the river thus made navigable for the largest river steamers from Vienna to the Black Sea. It is said that the work cost nearly $10,000,000.

The Steam Engineering Class of the Young Men's Institute, 222-224 Bowery, New York City, opened its 1896-97 session on the evening of Oct. 7, 1896, and will continue open Wednesday and Friday evenings until April 29, 1897. The class is in charge of Mr. Wm. H. Weightman as usual. Its object is the instruction of all employed or expecting to be employed in the practical operations of engines, boilers and machinery, and desirous of gaining a knowledge of or improving themselves in the theoretical branches, rules and practice of steam engine, boiler and power transmission calculations. Those desiring to avail themselves of the opportunity should join the class at once.

In the *Engineer* for Oct. 9, Mr. Chas. Rous-Marten gives some facts about the longest regular run without stops in the world. This run is made daily on the Great Western Railroad of England, between Paddington and Exeter, and is 194 miles long. The average speed according to schedule is 51.7 miles per hour. The train usually consists of six cars carried on trucks, and weighing 140 long tons behind the engine. The engine hauling the train is a 19 by 24 with one pair of drivers 7 feet 8 inches in diameter, and a four-wheeled leading truck. The steam pressure is 160 pounds, and the heating surface 1,561 square feet. The grades are easy and the road favorable to fast running, but at Bristol the train passes around a loop to avoid the station and the curves in the track at this point compel the speed to be kept down to about 10 miles per hour. There is also one grade of 1 in 81.

The lens for the great telescope of the new observatory at Lake Geneva, Wis., has been completed after two and a half years' labor, and now lies at the workshop of Prof. Alvin Clark, in Cambridge, awaiting the orders of the Chicago University authorities. Its focal distance is 61 feet; the extreme diameter of the clear aperature is 41⅝ inches. The crown is about 3 inches thick at the middle, and 1¼ inches thick at the outer edges, and weighs 205 pounds. The flint weighs 310 pounds. The lens and its iron ring and cell weigh about 1,000 pounds. The cost of the glass plates, in Paris, was $40,000, and the entire cost of the lens is estimated to have been $100,000. For its journey West it will be wrapped in flannel and bedded in curled hair in a box mounted on springs and packed with excelsior in a larger box. It will ride in the center of a parlor car, and will be accompanied by four men.

Last November one of four vertical triple-expansion Corliss engines, built by Fraser & Chalmers, Limited, of Chicago, for the De Beers Consolidated mines, Kimberly, was tested to see if it met the guarantee of the builders that the dry steam consumed per brake horse-power should not exceed 145 pounds. The engines were each of 225 horse-power. The cylinders are 11½ inches, 19 inches and 30 inches in diameter by 36 inches stroke. The engine has two cranks 90 degrees apart. The cylinders are jacketed. The steam pressure during the test averaged 123.7 pounds above the atmosphere, the vacuum 11.5 pounds. The engine made 74.6 revolutions per minute, and developed 223.86 brake horse-power and 234.32 indicated horse-power. The frictional horse-power was thus only 4.4 per cent. The dry steam per brake horse-power was only 13.5 pounds, and per indicated horse-power, 12.9 pounds, a truly notable result. The test lasted five hours.

A notable steam yacht has been designed by Mr. Charles D. Mosher, and is now under construction at Upper Nyack for Mr. Charles R. Flint, of New York City. The boat is to have a guaranteed speed of 33 knots, or about 38 miles per hour. It will be 122 feet long, 12½ feet beam and 4 feet draft. It will be driven by twin screws and quadruple-expansion engines of 2,000 horse-power. There will be independent air, feed and circulating pumps, electric-lighting plant, and blowers for forced draft. Steam will be supplied by two Mosher water-tube boilers. The hull of the boat will be divided into seven compartments by water-tight bulkheads. The coal bunkers will be of large capacity. The fittings of the boat will be excellent, but the most interesting feature is the facility with which all the upper works can be removed and replaced with a turtle-back deck and two conning towers. Simultaneously with this change the boat can be fitted with torpedoes and rapid-firing guns, thus converting the yacht into one of the fastest and most effective of torpedo boats.

The last session of the Mexican Congress amended the existing patent law of that country, so that article 33 reads as follows: "The owner of a patent is obliged to prove to the Department of Encouragement at the end of each period of five years of the life of the patent that, with a view of maintaining it for another five years, he has paid into the general Treasury of the Federation the sum of $50 at the close of the first five years, or $75 at the expiration of ten years, and $100 at the expiration of fifteen years. All these payments have to be made in Mexican dollars. The term within which these payments have to be proved shall be two months after the conclusion of each period of five years. This term cannot be extended. Persons who up to the promulgation of this law shall have lost their patents under Section 3, Article 37 of the law of June 7, 1890, may avail themselves of the benefits of this law to save their patents, provided they pay the proper fees within three months of such promulgation. But the patent thus revived is without prejudice to the rights acquired by other parties subsequently to the declaration of forfeiture."

The Joint Select Committee, created at the last session of Congress, to investigate and report upon the question of the use of alcohol free of tax in the manufactures and arts, have prepared a series of interrogatories, which will be distributed throughout the country to such parties as are thought to be interested in the question. It is the earnest desire of the committee to secure all possible information bearing upon the subject, and it is hoped that parties interested will submit their views to the committee promptly. Sets of the circular letter and blank for replies will be supplied to any applicant by addressing the Chairman, Room 21, Senate Annex, Washington, D. C. The committee, which is composed of three members of each House, will probably assemble in Washington soon after the middle of November for the purpose of formulating a report to Congress accompanied by the draft of a law which will place domestic industries on as favorable a basis as similar industries in foreign countries. During their sessions in Washington hearings will probably be given in order to supplement the information obtained through the interrogatories sent out by mail.

The New York *Tribune* says that the United States Naval authorities have tested and found highly satisfactory an improved Howell torpedo. The new torpedo is larger than any of that type previously tried, some of its dimensions being as follows: Extreme length, 14 feet 6 inches; greatest diameter, 17 inches; net weight of guncotton in charge, 174 pounds; net weight of water-wetting charge, 43.6 pounds; net weight of dry guncotton in primer, 2.35 pounds; immersed displacement in sea water, 1,150 pounds; launching weight of torpedo, 1,130 pounds; reserve buoyancy, 20 pounds; mean speed over range of 400 yards, 33 knots; over 600 yards, 30 knots; over 800 yards, 28.5 knots. The extreme effective range, as adjusted for regular service, is 1,000 yards; the deflection from beam fire at a ship with a speed of 17 knots, 5 degrees; weight of fly-wheel, 30 pounds; most efficient fly-wheel speed at start, 9,600 revolutions per minute; pitch of screw at start, 14 inches; pitch of screw at finish, 29 inches; diameter of screws, 10 inches. The total displacement weight of a center pivot launching tube is 2,203 pounds; that of the tube proper, 1,153 pounds; of a carriage, 422 pounds; of a racer, 98 pounds; of the motor, 330 pounds; of the piping to swivel, 200 pounds. The weight of a powder blast in the cartridge case is six ounces.

The North Atlantic squadron passed through the heavy gale of last month when on its way from Hampton Roads to New York. Most of the ships behaved well in the storm, but the crew of the battle-ship *Indiana* had an experience they will not soon forget. Captain Evans gave an account of it, from which we take the following: "Soon after we left Hampton Roads Monday all four of the 8-inch turrets broke loose at once from their gearing. That was about 2 o'clock in the afternoon. We went to work with 5-inch hawsers to tie the guns up. We tied the two forward turrets together by binding the guns each to the other and fastening the hawsers to the bits, and managed the aft ones the same way. It was a very hard job. About 2 o'clock the next morning the forward ones snapped their hawsers and got loose again. The storm was then very severe, and the ship was rolling at an angle of 36 degrees. The decks were flooded with water, and this, with the pitching of the ship, made working on deck very dangerous. To make matters worse, the forward 13-inch gun turret got loose, and those enormous guns began thrashing about in full command of the deck. We fastened a 5-inch hawser on the 13-inch gun and it snapped like a cotton string. We finally caught the big guns with an 8-inch hawser and tied them securely to the superstructure. It was an awful job, though, and we were in danger of being washed overboard every minute. All during the work the deck was completely flooded."

A series of interesting tests were recently made on short sections of wire cable in the laboratory of the Yorkshire College, Leeds, England, and described in *Engineering*. In making the tests it was found that none of the cappings supplied by the makers was at all satisfactory; most of them gave way at about one-half the breaking load of the rope, when taking the strength of the rope as the sum of the strength of the wires tested individually. After several experiments it was found that the only really satisfactory method of making the strength of the cap approximately equal to the strength of the rope is as follows: Before cutting off a sample length from the bulk of the rope, it is tightly bound with wire at about six inches from the end, and then cut off. The specimen is then tightly served with tarred band from end to end, in order to keep the strands in their proper position. The ends are then frayed out, and the end of each wire turned over; each end of the rope is then put in boiling caustic soda to remove tar and grease, thoroughly washed in hot water, then dipped in "killed spirits"—i. e., chloride of zinc, and afterward in molten solder; each wire then gets tinned. The ends are then put into split conical dies, and an alloy, consisting of lead, tin and antimony, is cast round it, which completes the capping process. The rope is then pulled apart in the testing machine, the ends being held in conical dies. The results of seven tests show that the breaking strains of from 12,960 pounds to 55,500 pounds for the different ropes were all from 93.4 to 96.2 per cent. of the sum of the strengths of its component wires.

Consul Merritt, of Barmen, describes Herr Linde's process for the manufacture of liquid air, whereby also oxygen gas is obtained at a cheaper cost than that produced by the methods now in use. A powerful engine compresses air, which is cooled, as far as possible, by ordinary refrigerating methods and passed into a spirally coiled pipe a hundred yards long. This pipe is enclosed in a second spiral. By means of a throttle valve at the end of the inner spiral, a certain proportion of the compressed air is allowed to expand in the space between it and the outer pipe. Thus the stream of compressed air from the pump is cooled by that portion which has been allowed to expand, and arrives at the throttle valve in a colder state than the portion that preceded it. Consequently, it reaches a still lower temperature on expansion, cooling yet more powerfully the advancing stream in the inner tube. By carrying this cumulative cooling effect sufficiently far, the circulating air is at least brought down to its critical point and liquefies, after which a continuous stream of liquid air is merely a question of engine power. The cycle of operations can be readily apprehended; there is compression, expansion in a closed chamber, and utilization of the cold thus produced to repeat the cycle from a lower initial temperature. The apparatus produces with the greatest ease a substance for which there is already a large industrial demand—oxygen gas. During the process just described, the air becomes steadily richer in oxygen until that gas forms some 70 per cent. of the product. This relatively pure oxygen is sufficiently good for certain purposes, and it may be further purified from nitrogen if desired.

The trouble encountered again during the past season with the Belleville water-tube boilers in the Northern line passenger steamers *North Land* and *North West*, especially the latter boat, has been the subject of a great deal of comment among engineers on the lakes, and rumors have been circulated about new boilers being adopted. Builders of the steamers have disclaimed any responsibility for difficulty with the boilers, as they hold that they opposed the adoption of them at the outset. Mr. Miers Coryell, who represented the French owners of patent rights on the boilers, and who, even up to the close of the passenger season this year, has been trying to straighten out the trouble, claims that the unsatisfactory operation of the ships has been due entirely to negligence in the management of the fire rooms. He writes from New York at considerable length on the subject, and in part says: "Among some of the practices which prevailed, and which the engineers estimated they could not prevent, were the following: Heavy fires, brought on by charging the furnaces with lumps of coal that were limited in size only by the dimensions of the furnace doors; ash pans full of dirt and clinker; furnace doors wide open half the time; damper doors kept wide open: boilers too full at times and again allowed to run scant of water, thereby damaging them; fireroom force cleaning a number of furnaces at a time, and in fact, conducting work of this kind at their leisure, allowing the steam pressure to drop as much as 100 pounds; then further delay by fires too thick to allow a passage of air through them, and a consequent discharge of clouds of black smoke instead of kindling fires in the furnaces. Then, too, the discharge pumps for disposal of ashes were run without a mixture of water with the cinder, which was equivalent to rotating them in emery. It would seem that they were purposely rendered useless, in a spirit of destruction and wickedness. As a result of this the boats would reach port with firerooms 18 inches deep with ashes.' —*Marine Review.*

Personals.

Mr. E. L. Langford has been chosen President of the Brooklyn & Brighton Beach, to succeed James Jourdan.

Mr. G. H. Clark, Jr., has been elected Vice-President of the Northampton & Hertford Railroad, with office at Newark, N. J.

G. M. Stewart, previously Acting General Manager of the Interoceanic Railway of Mexico, has been appointed General Manager.

Mr. Henry Kistner has been appointed General Foreman of Motive Power and Car Departments of the Monterey & Mexican Gulf.

Mr. H. L. Hawkins has been appointed Chief Engineer of the Oregon Improvement Company, with headquarters at Seattle, Wash.

Frederick A. Lex, formerly with A. Whitney & Sons, has become identified with the Lobdell Car Wheel Company of Wilmington, Del.

Mr. F. G. Patterson, President and Superintendent of the Altoona, Clearfield & Northern, was last month appointed as Receiver of the road.

Mr. J. A. Atwood, heretofore Principal Assistant Engineer of the Pittsburgh & Lake Erie, has been appointed Chief Engineer in place of Mr. F. E. House.

Mr. W. W. Wentz, Jr., has been appointed Secretary and Purchasing Agent of the Louisville, Evansville & St. Louis, with headquarters at Louisville, Ky.

Mr. Horace G. Burt has resigned as General Manager of the Chicago, St. Paul, Minneapolis & Omaha, to become Third Vice-President of the Chicago & Northwestern.

Mr. Edwin Hawley, of New York, Vice-President of the Minneapolis & St. Louis, was on Oct. 6 chosen Vice-President of that road to succeed Mr. W. L. Bull, resigned.

Mr. H. Walter Webb, Third Vice-President of the New York Central, New York City, has been appointed Temporary Receiver of the Ogdensburg & Lake Champlain Railroad.

Mr. Frank J. Sarnan, Master Mechanic on the Manitou Beach Railroad, has been appointed Superintendent, succeeding Mr. George C. Mills. Mr. Charles Sarnan succeeds him to the position of Master Mechanic.

M. J. F. Sechler has resigned as Master Mechanic of the Louisville, Evansville & St. Louis at Princeton, Ind. Mr. F. C. Cleaver, formerly Master Mechanic of the Vandalia line at Terre Haute, Ind., has been appointed in his stead.

Mr. Charles E. Levy, President of the New Orleans & Western Railway, has resigned, owing to poor health. Mr. W. Mason Smith, the Vice-President, was chosen to fill the vacant position, and Mr. W. W. Pierce was elected Vice-President.

Mr. Henry Fink, one of the Receivers of the Norfolk & Western, has been chosen President of the reorganized company which took possession of the property October 1. Mr. F. J. Kimball, heretofore President and Receiver, is Chairman of the Board of Directors.

Mr. W. H. Brehm has been appointed Master Mechanic of the Missouri, Kansas & Texas north of Denison, Tex., with headquarters at Parsons, Kan. Mr. John L. Wigton has been appointed Master Car Builder of the lines north of Denison, Tex., with headquarters at Sedalia, Mo.

Mr. W. H. Stark has resigned his position as Master Car Builder of the Wheeling & Lake Erie Railway Company to give his attention to railway supply matters. Mr. Stark has an interest in several valuable railway appliances patented by him, which will probably be on the market in the near future.

Gen. Horace Porter, who has been first Vice-President of Pullman's Palace Car Company for many years, has resigned that office owing to his election to the position of Chairman of the Board of the St. Louis & San Francisco. The former second Vice-President, Mr. T. H. Wickes, succeeds General Porter as first Vice-President.

Mr. J. M. Wallace, Superintendent of Motive Power of the Pennsylvania Railroad at Altoona, Pa., will succeed the late Mr. Neilson as General Superintendent of the Philadelphia & Erie and the Northern Central Railroad. Mr. Wallace will be succeeded as Superintendent of Motive Power by Mr. W. W. Atterbury, now at Fort Wayne.

Mr. E. W. Knapp, Master Mechanic of the Mexican National, at Acambaro, Mex., has been transferred to the City of Mexico, and Mr. R. Fitzsimmons, Acting Master Mechanic at the latter point, has been appointed Foreman of Engines at Saltillo. Mr. E. D. Stegall has been appointed Master Mechanic of the Mexican National at Acambaro, Mex.

The promotion of Mr. F. W. Brazier from the position of General Forman of Car Works to that of Assistant Superintendent of Machinery of the Illinois Central Railroad will please his many friends. Mr. Brazier came from the Fitchburg road to take charge of the plant of the Chicago, New York & Boston Refrierator Company at Elsdon, Ill. Later he accepted his recent position on the Illinois Central.

Mr. Walter A. Scott, General Superintendent of the Chicago, St. Paul, Minneapolis & Omaha, has been appointed General Manager of that road, with headquarters at St. Paul, Minn., to succeed Mr. H. G. Burt, and the office of General Superintendent has been abolished. Mr. Scott was formerly Master Mechanic for ten years and Assistant Superintendent of Motive Power and Machinery for two years on the Chicago & Northwestern.

Last month we were in error in stating that Mr. R. P. C. Sanderson had resigned the position of Division Superintendent of Motive Power on the Norfolk & Western Railroad. The office of the General Superintendent with the staff belonging to that department was abolished on the Norfolk & Western Railroad, and Mr. Sanderson's position as a staff officer of the general superintendency was abolished with the general superintendency, but the duties of that position are being performed by him much the same as before, but under the Superintendent of Motive Power's supervision instead of under the General Superintendent's.

Mr. Robert Neilson, General Superintendent of the Philadelphia & Erie and Northern Central roads of the Pennsylvania system, died very suddenly at his home in Williamsport, Oct. 12. Mr. Neilson was born in Ontario, Canada, Aug. 19, 1837. He graduated from Rensselaer Polytechnic Institute in 1863, and immediately entered the service of the Pennsylvania Railroad as rodman on the Philadelphia & Erie. In 1865 he became Resident Engineer of the middle division of that road. In 1870 he was promoted to the Superintendency of the Western Pennsylvania division, and in 1874 he was appointed to a similar position on the Elmira and Canandaigua division of the Northern Central. In 1881 he was made General Superintendent of the Philadelphia & Erie and of the Northern Central north of Harrisburg, and in 1884 his responsibilities were extended to embrace the entire Northern Central. The duties of this position he discharged with great ability until his death. He had been in the service of the Pennsylvania for over 30 years.

Equipment Notes.

The Green Bay & Western is asking bids on 150 box cars.

The Cudahy Packing Company is in the market for 50 refrigerator cars.

The Winona & Western Railroad has ordered two locomotives from the Dickson Locomotive Works.

The Lima Locomotive Works have an order for one Shay locomotive for the Morning Mining Company.

The Louisville & Nashville has given out a contract for 15 engines, and it is asking bids on 300 gondola cars.

The Keokuk & Western road has contracted with the Rogers Locomotive Works for three 10-wheel locomotives.

The Spokane Falls & Northern Railway has contracted for one six-wheel connected engine with the Baldwin Locomotive Works.

The Michigan-Peninsular Car Company, Detroit, have been given an order for building 1,000 freight cars for the Erie Railroad.

The Georgia railroad, it is reported, has placed an order for 100 freight cars with the Youngstown Car Manufacturing company.

The Portland Company, Portland, Me., has an order for five four-wheel connected engines from the Grand Trunk Railway of Canada.

The St. Charles Car Works have delivered to President E. H. R. Green, of the Texas Midland Railroad, the private car recently completed for him.

Wells & French have been given the contract for building 100 refrigerator cars for Swift & Co. The latter company are asking bids on 50 stock cars.

The Stone, Coal and Lumber Freight Line of Atlanta, Ga., has recently contracted with the Car Trust Investment Company of New York for 200 cars.

The Rock Island Railroad is building at its own shops two fast locomotives of the designs recently gotten up by Mr. Wilson, and which have proved so satisfactory.

The International Great Northern has built a number of drawing-room cars for service between St. Louis and Galveston. They have 12 sections, and are supplied with buffets.

It is again reported that the Butler & Pittsburgh will soon be in the market for much of its new equipment, but the report is denied, and it is said that no orders will be placed before spring.

Rotary Acceleration.

A correspondent of the *Practical Engineer*, in commenting on an editorial in that paper on "train resistance," has the following to say about rotary acceleration:

"You remark that there is the rotary acceleration of the wheels and axles, which has, we believe, been nearly always neglected, but which forms, nevertheless, a very important part of the whole resistance, prompts me to say that there is an equal and universal tendency to ignore the effect of rotary acceleration in our text-books on mechanics. How often do we not find the little carriage running down an inclined plane with an acceleration calculated with total disregard of the rotary acceleration of the wheels? *and without any hint that any such a connection to the calculation is needed.* One occasionally even finds in standard text-books a problem given, in which a body is expected to *roll* down an inclined plane in exactly the same time as it would slide down if there were no friction. I take the following exercise from a well-known elementary text-book: "Show that the velocity acquired by a body rolling down a smooth inclined plane is the same as that acquired by falling vertically through the height of the plane." It appears to me that such an exercise, found with others in good text-books, is in itself a proof that the difference between sliding and rolling is not sufficiently brought to the front by teachers of mechanics. It is assumed in these cases that a body rolling down an inclined plane or along a smooth surface, under the influence of any force, will be subject to the same acceleration as when sliding down the plane or along the surface under the same force, which, of course, is not true.

A very simple experiment serves to bring out forcibly the great influence of rotary acceleration upon the velocity acquired by wheels of different types. If a table napkin ring (a turned one) and a common cotton reel of nearly equal weight and diameter be procured, and set to roll down a drawing board tilted to a good inclination, it will be found that the reel will reach the bottom much sooner than the ring, owing to the mass of the ring being concentrated so near its periphery compared with the reel, that a much larger proportion of the energy due to the fall has to be spent in giving the ring its rotary acceleration. Indeed, in the case of a ring indefinitely thin, just one-half the energy is required for rotary acceleration, and the other half for the movement of translation. And hence, if a wheel could be made with all its mass concentrated in the center, such a wheel would reach the bottom of an inclined plane by the time the indefinitely thin ring had got half way only.

European Boiler Practices.

Mr. R. S. Hale, M. E., has recently submitted a report to the Steam Users' Association, of 31 Milk street, Boston, Mass., giving the results of his investigation upon European boiler practices, Mr. Hale having visited England, Germany, France and Belgium for this purpose. From a summary of it by the *Engineering Record* we take the following:

Regarding the types of boiler in use in the year 1895, Mr. Hale found that in England 38 per cent. were Lancashire and similar types, 23.7 per cent. Cornish, 6.8 per cent. of the externally fired cylindrical type, while the boilers of the water-tube type were found to be 1.8 per cent. In France the percentage of Lancashire and Cornish boilers is exceedingly small, while the externally-fired cylindrical leads the list at 57.3 per cent. The externally-fired multi-tubular, which evidently corresponds with the American return horizontal tubular boiler, represents 13.4 per cent. of the boilers in France, while none was found in England. The percentage of water-tube boilers in France was 5.7. In Germany the Lancashire represents 35 per cent., the Cornish 15 per cent., the externally-fired cylindrical 14.8 per cent., externally-fired multi-tubular 5.8 per cent., the locomotive 17.3 per cent., water tube 4.6 per cent.

The Lancashire boiler which, as we previously mentioned, is found in England, is generally 30 feet long by 7 feet 6 inches in diameter. It has two internal flues about 3 feet in diameter and a grate in each of them generally 6 feet long. Galloway or cross-tubes, 6 inches in diameter, five to each flue, are often placed in the flues back of the bridge wall. The gases after passing through the flues pass underneath the boilers to the front and then back along the sides to an underground flue. Such a boiler would have 36 square feet of grate, and 1,000 square feet of heating surface. Mr. Hale said that when built for 160 pounds steam pressure, the boiler costs about $2,500 in England, and that it will easily deliver 6,000 pounds of steam per hour and more, although at this rate it is not very economical; but where used at a lower rate of combustion, or in conjunction with an economizer, it is as economical as any type of boiler. The boiler is easily cleaned and the outside is of easy access. The Cornish boiler is exactly like the Lancashire except that it has but one flue, placed in the center in England, while in Germany it is frequently placed to one side, with the idea of improving the circulation. The Galloway boiler is generally classed as a Lancashire, which it resembles in every respect except that the two furnaces meet back of the bridge wall in a single large flue filled with Galloway tubes.

Mr. Hale finds English workmanship fully equal to our best. In England, he states, no punching is allowed and the plates are always planed on the edges and then drilled in place. Steel is being used almost exclusively in England, while iron is still preferred in some places on the Continent. English makers usually figure on 20 years as the average life of a boiler.

Mr. Hale said that the internal flues in the Lancashire boiler are generally welded along the longitudinal seam, and the cross or Galloway tubes are frequently welded in. He did not hear of any case of welding a boiler shell itself. Mr. Hale stated that corrugated flues were made in various ways, and that while they were considered better in England, it was thought that most frequently the improvement did not warrant the expense. In comparing steam pressures it was found that for an American mill operating under 150 pounds pressure, the corresponding practice would be 200 pounds in England, 180 in Alsace and 150 in Belgium and Germany.

Economizers were much more general in Europe than in American practice. One economizer was generally put in for each battery of boilers, making the heating surface the same as the heating surface in the boiler. He noted that in some plants where economizers had been taken out the heating surface of the boilers had to do more than double to get the same economy. One advantage claimed for economizers and the Lancashire boilers was that the large amount of hot water in them offered a reserve of heat for a sudden call.

The use of superheated steam is very much in the air all over England, and in Alsace it is fairly general, about 500 superheaters being in use. There never has been any doubt that they save from 10 to 20 per cent. of coal, but the difficulty has been, Mr. Hale said, in the lubrication of the engine cylinder and in keeping the joints of the superheater tight.

Regarding grates, the practice in Germany in the case of under-fired boilers was to incline the grates downward to the rear as much as 18 inches, as it was thought to be easier for the firemen and to give better combustion.

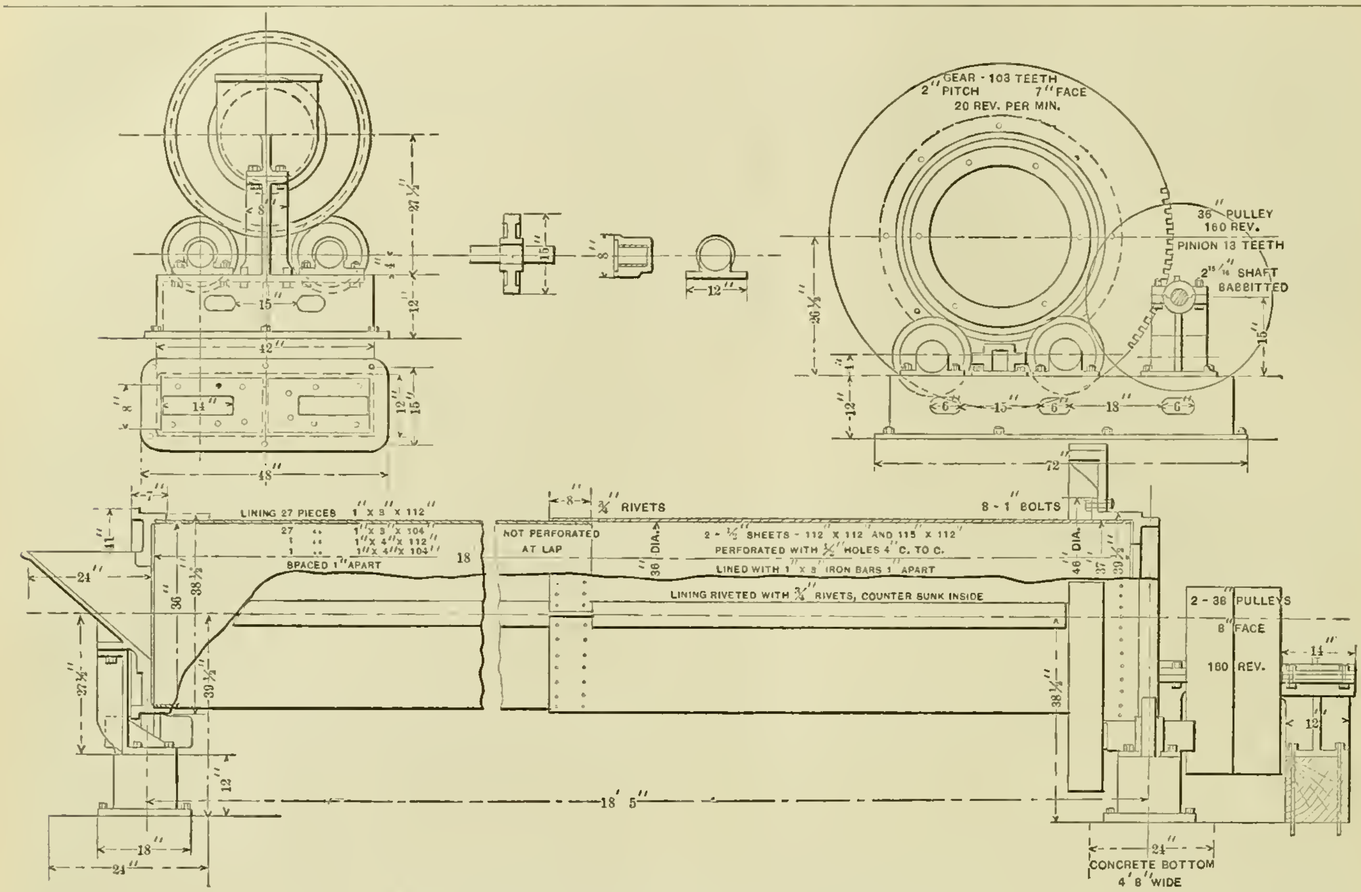
The report states that several forms of economical stokers were in use in England, perhaps over one-fourth of the boilers being equipped. Mr. Hale divides the stokers into two classes, the coking and sprinkling stokers, the former type feeding the coal to the front, where it cokes and is then carried to the rear by the reciprocating motion of the gratebars. The sprinkling stokers throw the coal over the grate by means of revolving or oscillating shovels. Mr. Hale found stokers of the former type to be the best known. It is believed in England that no stoker absolutely prevented smoke, but that both types very largely diminished it, the coking stoker having the advantage in this respect. The opinion is divided as to the economy of stokers. The most general reason for their adoption was the diminution of smoke, the laws being very strict. They also permit of the use of a cheaper fuel, but Mr. Hale is inclined to believe that the net saving in this direction after paying the interest and repairs amounted to little or nothing. The use of stokers and coal-handling appliances together was thought to save about one-third of the boiler-room labor in large plants.

In Germany grinding the coal to a powder and blowing this dust coal mixed with air into a hot combustion chamber was a method that was being experimented upon in several plants and was meeting with considerable favor. The fine dust, however, was not only very dirty to handle, but exceedingly liable to spontaneous combustion, and the problem of grinding and storing it had not as yet been commercially solved.

Boiler fittings abroad were noticeably heavier and stronger than in America and the use of a spring-loaded safety valve was looked upon with distrust. The average quality of the boiler and pipe coverings did not impress Mr. Hale as favorably as those in America. He had seen wood and even rope covering on high-pressure piping. In this respect Mr. Hale also calls attention to the wise practice of covering the top of boilers with a thick cheap covering to prevent the radiation of heat, this being generally done abroad.

In speaking of boiler operation Mr. Hale found that the surfaces of boilers were kept in a cleaner condition abroad than in this country. In some places they run the boiler until the specific gravity of the water is 1.005 and then they blow out and clean the boiler. In England they use soda, lime and potash in the boilers according to the impurities. In mills the fires are banked at night, while in electric stations the custom was very general to let the fires go out when they were not needed. Mr. Hale ascribed this difference not to the fact that a mill fire is out of use for a less time (14 hours) than an electric station fire (16 hours), but to the fact that in the case of a mill the new fire must be started at, say, 4 a. m., when it would involve an extra shift of men, whereas in electric stations the fire is needed at about 4 p. m. and involves no extra labor. From data given by several plants it was found that the cost of banking fires was about 40 pounds of coal per day per square foot of grate. The wages of the firemen are about $1.10 per day in England, 80 cents in France and Belgium, and 87 cents in Germany.

In boiler economy he could not see that they were either ahead or behind us; they get from 60 to 80 per cent. of the heat in the coal according to the air supply and evaporation per square foot of heating surface. None of their engineers had ever found any combustible gases in the chimney except occasionally a little CO (carbonic oxide). Most of their tests, however, left some zero to 15 per cent. of the heat unaccounted for, which may be radiation or error. Some said one, some the other. No one had experimented as to why it is harder to supply the right amount of air to one kind of coal than to another, though they had all gone as far as to realize the immense importance of the air supply as compared with any



Scrap Rattler at the Schenectady Locomotive Works.

other factor in boiler economy, and also to realize and to experiment on the amount of air that leaks through the settings of some types of boilers to the injury of the economy. Frequently more air has been found to leak through the settings than came through the fire. In some plants on the Continent they were painting the brick settings with a heavy tar paint to make them air-tight, and occasionally even inclosing them in sheet-iron casings. In Germany they have an instrument called the gas-balance which shows the per cent. of CO_2 (carbonic dioxide) in the flue gases on a dial like a steam gage. If not too delicate it promises to be of great practical use.

The special instruments used for boiler testing were the ordinary thermometer for low flue temperatures, and for high temperatures the electric resistance pyrometer, in England; the thermo-electric pyrometer used in Germany, and the mercury thermometer with compressed nitrogen or carbonic acid over the mercury, reading to 550 degrees Cent. (about 1,000 degrees Fahr. English measure). For analyzing flue gases the Orsat apparatus is most commonly used.

A Scrap "Rattler."

At the Schenectady Locomotive Works a great deal of scrap is worked up into forgings for the parts of locomotives. It was found that much better forgings could be made if the scrap was clean, that is, free from rust, scale and other impurities. In order to clean the scrap they have erected a rattler, shown by the engravings herewith. This consists of a wrought-iron cylinder 36 inches in diameter and 18 feet long, which is mounted on two pairs of friction rollers clearly shown in the end views. The drum is revolved by suitable gearing at one end, driven by a belt and pulleys. The scrap is fed into the drum at one end by a sort of hopper, and has a downward inclination from that end to the other, so that as it revolves the scrap is moved slowly from the mouth, as it may be called, toward the opposite end, where it is delivered freed from its impurities.

Some of our readers will remember Mr. Outerbridge's experiments, which showed that iron was increased in strength by rattling. Whether the forgings made of rattled scrap are stronger than those made from iron not treated in this way is probably not known.

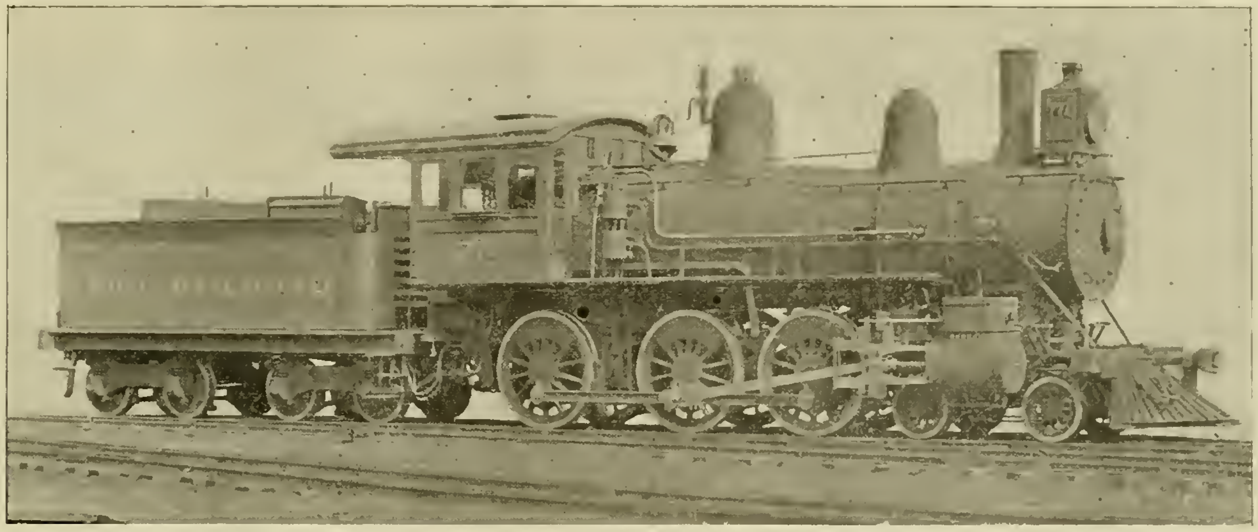
The Aylmer Branch of the Canadian Pacific Railway Operated by Electricity.

The latest development in Canadian electric railway work is the equipping of the Aylmer branch of the Canadian Pacific Railway with electric service. This line extends from Hull, a suburb of Ottawa, to Aylmer, where it connects with the Pontiac Pacific Junction Railway, extending 60 or 70 miles up the north side of the Ottawa River. The section from Hull to Aylmer has been leased by the Hull Electric Company for a period of 35 years, the understanding being that, besides passenger and mail traffic, they are to handle all through and local freight delivered to them by either the Canadian Pacific Railway or the Pontiac Pacific Junction Railway. As they are the only connecting link with the Pontiac Pacific Junction road, it can readily be understood that the quantity of freight is considerable, amounting usually to 50 or 75 cars per day. This freight is mostly handled at night, leaving the road free during the day for passenger traffic.

At the Aylmer end of the line the company owns 60 acres situated on Deschesne Lake, a sheet of water 3 miles wide by 27 miles long; an ideal spot for sailing and boating, thus forming a strong attraction for the Ottawa citizens. Indeed, the traffic has been far beyond expectations, and the train service had to be increased, until they are now running 36 regular trains each way per day, besides special excursion trains.

The power is obtained from Deschesne Rapids, where the lake of the same name empties itself into the Ottawa River, at a point midway between the termini of the road. The turbine wheels are of the "New American" type, manufactured by William Kennedy & Sons, of Owen Sound, Ontario, and operated under a head of nine feet. Four 60-inch wheels are now installed and space is provided for two more.

The electrical equipment of the power-house consists of two M. P. 4-200-425 generators, built by the Canadian General Electric Company. For controlling the output of these machines there is a switchboard, consisting of two generator panels, two feeder panels and a total output panel, all of the General Electric standard type and supplied by the Canadian Company. Besides these, there are three panels containing the "Barbour" water-wheel regulator, by which the current output of the generators is automatically kept constant by cutting in or out dead resistance as the load varies on the line. By this means the speed of the machines is kept con-



Ten-Wheel Passenger Locomotive for the Erie Railroad.—Built by the Brooks Locomotive Works.

stant and the variation in voltage is held within a very close limit. The car sheds and repair shops are also at Deschesne and are fully equipped with all modern appliances for handling and inspecting the rolling stock which at present consists of five closed cars and five open cars, besides a mail, baggage and express car and a locomotive. All the cars are mounted on two trucks each, and are each equipped with two G. E. 1,200 motors with K. 21 controllers. The closed cars are 42 feet long over all, and finished in mahogany throughout, the outside sheeting being also solid mahogany finish, in the natural wood.

The locomotive is of particular interest, being the first of the kind operated in Canada. It weighs something over 20 tons and is provided with double trucks, each axle being equipped with a motor. As all the wheels are driven, full traction advantage is obtained from the total weight and a draw-bar pull of 10,000 pounds can therefore be expected.—*Electrical Engineer.*

Ten-Wheeled Passenger Engine for Erie Railroad.—Built by the Brooks Locomotive Works.

The engine shown herewith is one of five ten-wheeled passenger engines built for the Erie Railroad by the Brooks Locomotive Works. They have 20 by 26-inch cylinders, driving wheels 62 inches in diameter, a boiler 64 inches in diameter, firebox 107¼ by 40¼ inches, 282 flues 2 inches by 13 feet 2 inches, a driving-wheel base of 13 feet 6 inches, total engine-wheel base of 24 feet 2 inches, and weigh in working order 108,000 pounds on the drivers. The total weight of the engine is 144,750 pounds, and of the tender 87,000 pounds. The boiler pressure carried is 180 pounds. The boiler is of the radial-stay type. The firebox is of carbon steel, the stays of Taylor iron. The engine truck has a swing motion and is carried on Paige steel-tired wheels. Other fittings are United States metallic packing, American balanced valves, Magnus bearing metal, Metropolitan and Monitor injectors, one each, McDowell inside boiler checks, Fox pressed steel truck frames, Kewanee brake beams, Morris steel-box lids, French springs, Magnesia boiler covering, pressed steel cylinder-head casings and boiler front and door, Gould and Thurmond couplers, Kelly headlights, Westinghouse brakes, Gollman bell ringer, Ashcroft steam gage, Consolidated muffled pop valves, Detroit lubricators, and Midvale tires. The firebox rings are double rivetted. The main and side rods are of steel, with oil cups forged on, and all the axles are of hammered steel.

Cast-Iron vs. Steel-Tired Wheels.*

Recently this question was forced on the writer's attention by some articles and notices in the technical papers, which if believed in and followed up to their natural conclusion would lead one around to the steel-tired wheel makers' door for wheels for passenger cars, and necessitate the purchase and installation of wheel lathes at all the shops, increasing the first cost and maintenance cost of the passenger train considerably.

A search through the newspaper records of accidents for 1895 showed that there were just 22 cases of wrecks or derailments, freight and passenger, caused by broken wheels in the year, while there must have been something like 9,720,000 chilled iron wheels constantly in service under both passenger and freight cars during the year. The following is believed to be a fairly correct estimate of the number of accidents caused by broken wheels 1886 to 1894 inclusive:

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
37	27	48	28	37	39	46	48	33

While considering the question of relative safety, it is proper to mention that the steel-tired wheels are not the perfect panacea for the broken wheel problem. Reference to the M. C. B. reports on steel-tired wheels will show records of very considerable percentage of failures, and reference to the Board of Trade returns for the English railroads, and to the reports from the German Railway Union, show a considerable number of steel-tired wheel failures and some accidents from these, but the figures are not in such shape that comparisons can be made.

In a published report of some experiments made on the Pennsylvania Railroad, to ascertain the effect of heating the treads of chilled wheels,* it is stated that chilled wheels of various makes were placed in the sand and molten iron poured around the tread, when it was found that a large proportion of the wheels so tested cracked and broke, while the wheels made at the Altoona foundry would almost all stand this treatment without breaking. We can assume that wheels can be made at a reasonable cost that will stand such a test at other foundries as well as at Altoona, and can be bought at a small advance in price, if we insist on having them, and will pay for them. That a wheel in actual service will never be heated in such a manner as these test wheels were heated is reasonably certain. It is believed that leaving a red-hot brake shoe set against a standing wheel is very apt to cause cracked wheels, because severe strains would be set up in the plates and ribs due to the local heating.

Assuming that there are about 34,000 passenger equipment cars in constant service and that the numbers of wheels in service under these cars (four and six-wheel trucks) would approximate 306,000; that a first-class chilled 33-inch wheel weighs 600 pounds and that the average weight of the steel-tired 33-inch wheels (see M. C. B. report of 1895) is 802 pounds—some of them weigh over 1,000 pounds—this would mean that the difference in the weight of this many wheels alone, as between cast-iron and steel-tired wheels, would be 30,900 tons, which we would be burning coal to haul, at speeds up to and over 60 miles per hour, around the country.

Now, as regards the running qualities of steel-tired vs. chilled

*From a paper before the Southern and Southwestern Railroad Club by R. P. C. Sanderson.

* The results of these experiments were published in THE AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL for June, 1896, and have not appeared elsewhere, except as they have been copied from or have been suggested by our account.—EDITOR.

wheels, it is an indisputable fact that chilled wheels can be turned out equally true for much less cost. I have it on certain authority that it costs to grind a pair of new 33-inch wheels, mounted on the axle, for labor, 18 cents; emery wheel worn off, 3 cents; per pair, 21 cents. Regrinding old wheels on the axle, average for labor, 22 cents; emery wheel worn away, 6 cents; per pair, 28 cents. And these wheels, when ground, are just as true as any pair of steel-tired wheels ever turned out of a lathe.

Reference again to the report of the Committee on Brakeshoe Tests shows that the friction and loss of metal, where soft steel shoes were used on steel tires, was far greater than when soft steel shoes were used on cast-iron wheels. The inference is perfectly plain that on curves the rail wear from the flanges of steel-tired wheels will be greater than from chilled iron wheels, making a harder pulling train, and necessitating more frequent renewals of rails, which are expensive.

Having touched on the question of safety, weight, running qualities and rail wear, let us look at the very important question of first and final cost.

A really first-class chilled wheel, cast in contracting chills, can be produced from high-grade materials, including royalties, at a foundry cost of $4.60 each, or, say, at a selling price of $5 each. For a pair of such, $10; add for cost of grinding true, 21 cents; cost of wheels when mounted, exclusive of axle and cost of boring, $10.21 per pair.

We do not seem to be able to buy a really first-class article in the way of a steel-tired wheel for much under $50 each, although some that promise well are offered at (turned) $40 each; two such, $80. Difference in favor of the ground cast wheels, $69 79 per pair; for an eight-wheel car this is $279.16 per car; for a 12-wheel car, $418.74 per car.

A reputable firm of steel wheel makers guarantee their wheels (costing $50 each new) for 260,000 miles; the M. C. B. guarantee for chilled wheels under the same service is 60,000 miles.

The steel-tired wheels will average 3½ turnings to make the 260,000 miles. First cost of a pair of steel-tired wheels, say $80; cost of 3½ turnings, shop handling and machine work, $5.25; cost of 3½ removals and replacements at 60 cents, $2.10; total, $87.35. Deduct value of scrap, say 1,108 pounds at $8 and $10 per ton of 2,240 pounds, $4.94; cost per pair of steel-tired wheels for 260,000 miles, $82.41, exclusive of interest account; 260,000 miles represents about eight years and eight months' average service.

Assuming from the above that we would need to use 4⅓ pair of chilled wheels to make 260,000 miles, we have cost of 4⅓ pair of chilled wheels ground, $43.91; cost of 4⅓ replacements at 60 cents, $2.60; total, $46.51. Value of scrap, say 3,120 pounds, at $10 per ton of 2,240 pounds, $22.41. Cost of chilled wheels to run 260,000 miles, $24.10, a difference in favor of the chilled wheels per pair at the end of 260,000 miles, say $58.31.

Assuming that there are, as before mentioned, 34,000 passenger equipment cars in constant service, and making allowance for the number of six-wheel trucks under a portion of them, the difference in the amount of money invested in the one item of first cost of wheels alone would amount to about $1,863,540; and this does not include the extra cost of stock wheels, machinery, etc.

Reviewing all the above arguments which, while not pretending to absolute accuracy in some respects, are as correct as necessary, it seems proper to draw the conclusion that a really first-class 600-pound 33-inch chilled wheel, ground true, costing perhaps 30 cents to 50 cents more than an average wheel, bought on rigid test and guarantee, especially marked and reserved for passenger service, is good enough for ordinary United States railroading.

It would be hard to find any more elegant examples of the printers' and engravers' arts than the souvenir numbers of the *Street Railway Review* and the *Street Railway Journal*, both issued last month on the occasion of the convention of the American Street Railway Association at St. Louis. And when we say that the reading matter is as interesting as the press-work is good, we can add nothing in way of praise.

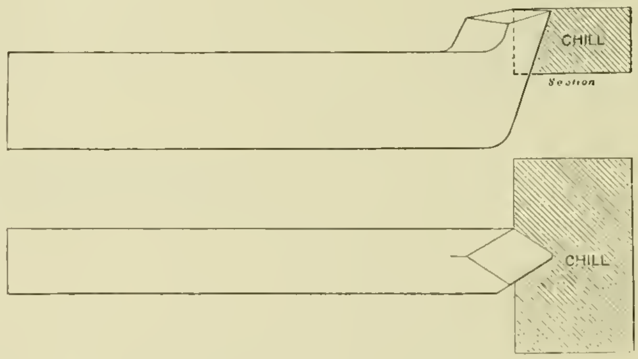
An important feature of *Harper's Magazine* for several months to come will be Poultney Bigelow's series of papers on the "White Man's Africa," treating in the author's original and striking way the new continent recently opened up to European exploitation. The first paper, in the November number, will give a novel view of Jameson's raid, from material placed in the author's hands by an English physician and a Boer official — thus presenting both sides of this remarkable episode. The series is the result of a journey to South Africa undertaken by Mr. Bigelow for *Harper's Magazine*, and is to be illustrated from photographs specially made for the purpose.

Cast-Iron Tools.

The illustrations and description of the cast-iron tools published in the October number appear to have interested so many persons that it is thought a description of the way they are made will not be out of place. They are cast from the ordinary wheel iron used in the Altoona foundry for making car wheels. The composition of this is from 30 to 35 per cent. of charcoal iron, 15 per cent. of coke iron, 5 per cent. of steel, and the balance old wheels made in the Altoona foundry. The coke iron is No. 2 foundry, and the specifications are that the silicon in it shall not exceed from 1 to 1.25 per cent.

The tools are cast from wooden or metal pattern, and of any form required. The chill or chill mold consists of a block of cast iron about one inch thick, and for a tool whose body is 1 by 1½ inches the chill is about 2 by 3 inches. This is notched out to the form of the point of the tool as shown in the illustration herewith, and is placed in the sand in the position in which it shown. The tools are cast with the point up, but the flasks are tipped up at the back end or heel of the tool so that the iron will be sure to fill out the point before it becomes cooled.

On inquiry, we found that these tools are not used in the wheel shops for turning axles nor for steel tires. One reason given is that they are liable to break under the set-screw, when fastened in the tool post. This difficulty may be overcome by putting a heavy piece of steel above or below the tool, before it is screwed



fast. One of the men using these tools informed the writer that he can do considerable more work with them for the reason that the work can be run at a higher speed, as they do not lose their temper or hardness by being heated, and that they can be heated red hot without being spoiled. There is no danger, either, of drawing the temper in grinding them on an emery wheel, as there is with steel tools. Surely, these are great advantages. They are, however, not suited for smooth-finishing cuts, as they will not hold a sharp cutting edge. As stated in our preceding article, they are used in lathes, planers and boring machines.

While in the toolroom, a cylindrical milling tool, 5 inches in diameter by 9 inches long, was shown to the writer, which was made out of an old steel axle and case-hardened. It had done a very large amount of service and had been brought in to be reground or sharpened.

M. C. B. Lithographs and Standards.

Lithograph copies of the drawings of Standards (sheets M. C. B., 1 to 12, inclusive) and Recommended Practice (sheets M. C. B., A to E, inclusive), illustrated on a reduced scale by 17 sheets in the back of the Report of Proceedings for 1896, may be had on a similar number of sheets, 30 by 38 inches, by applying to the Secretary at 974 Rookery Building, Chicago, Ill. Blue-prints can be taken from these sheets. The sheets will be sold at 25 cents each, plus postage when sent by mail. If needed for blue-printing, they should be shipped by express, and orders should specify by what express company they should be shipped.

Blue-print copies, 30 by 38 inches, of the drawings of Recommended Practice (see plates C, D, E, F and G in back of Proceedings for 1896), regarding axle and journal-box and contained parts for cars of 80,000 pounds capacity, may be had by applying to the Secretary, same address as above. These blue-prints will be sold at cost, which we now estimate will be about 30 cents each.

Pamphlets containing the text of the Standards and Recommended Practice, same as printed in the Proceedings of 1896, will be furnished similarly at 25 cents each.

Rulings of the Arbitration Committee.

When the Rules of Interchange were revised in June, 1896, the Arbitration Committee was authorized by motion to make a ruling on questions arising and not settled by the Rules, which ruling should stand thereafter as part of the Rules for the year. The following subjects which have been brought to the attention of the committee at its meeting, Sept. 16, by numerous parties, have been considered worthy of such ruling:

A. Because of the postal authorities becoming more strict in regard to the railway service mail, it has been suggested to the Arbitration Committee that the repair card stubs, referred to in Section 16 of Rule 4, might be allowed to accompany the bills instead of being forwarded to the car owner on or before the twentieth day of each month. The Arbitration Committee sees no objection to the suggestion being followed unless some car owner insists that Section 16, Rule 4, be literally complied with.

B. Section 25 of Rule 5 is intended to protect car owners from loss by reason of damage done in switching cars, therefore switching roads are not allowed to render any bills for damage caused while cars are in their possession. It is not intended to prevent switching roads from rendering bills against their immediate connections for any repairs of owner's defects which may be authorized by such connections when delivering the cars, and which existed upon the cars at the time of delivery. In such cases the delivering road must pay the bills of the switching road, and can only recover from car owners by certification on bills rendered by delivering road against the owner, that these owner's defects existed before the cars were delivered to the switching road.

C. Under the head of defects of wheels, a portion of Section (d) of Rule 3 of the Rules for 1895, has been inadvertently omitted from the Rules for 1896, and the following should be considered as a part of Rule 3, under the head of "Owners Responsible":

"Worn flange; flanges having flat vertical surfaces extending more than one inch from tread."

D. No provision is made in the Rules of Interchange as to scrap credit for old brakeshoes removed, and no provision is made for labor charges in renewing brakeshoes. The Arbitration Committee, therefore, recommends that no credit be allowed for the scrap in such cases, and that no charge be made for the labor of renewing the shoes.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued from Page* 273)

X.—Experiments with Different Shapes of Nozzles.

The experiments made with nozzles of the same opening, but of different inclinations and shapes, as shown in Fig. 68, gave no ground for thinking that the inclination of the conical sides of the nozzle or the overlapping form of the mouth exerts any noteworthy influence upon the action of the exhaust.

Prussmann's assertion, that the shape of the stack is dependent upon the inclination of the nozzle, here finds its refutation.

Conclusions.

The foregoing exposition and detail of experiments shows that

Fig. 69.

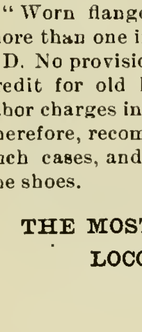


Fig. 70

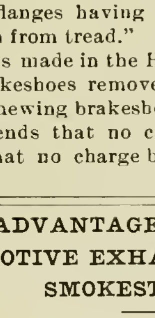
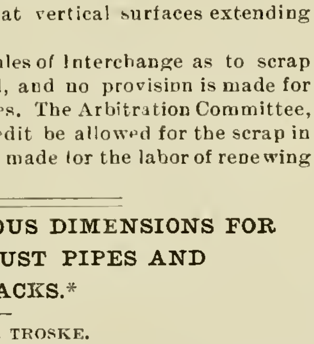


Fig. 71.



the action of a cylindrical stack upon the draft is dependent upon the inter-relationship of its size, that is to say, its free diameter d, its length l, and the distance x, from the nozzle (see Fig. 69), and also upon dlx.

If we change any one of these three dimensions in a stack the draft will also be changed. But by making a correlative change in the other two dimensions the new stack can be so designed that the same draft will be produced. Thus we can still retain a stack that will produce the same draft by making combinations with d, l and x.

The following cases are possible:

	Unchanged.	Changed.
1	d	lx
2	l	dx
3	x	dl
4	nothing	d, l, x

making four different forms.

In the conical stack as shown in Fig. 70, there must be added to the three preceeding dimensions a fourth, or the flare $\left(\frac{1}{n}\right)$ of that portion of the stack lying above the point of smallest cross-section, which thus makes the following combinations possible:

(1) Six combinations of twos;
(2) Four " " threes;
(3) One " " four;

thus making in all eleven forms.

The combinations of two are as follows:

	Unchanged.	Changed.
1	dn	lx
2	dl	nx
3	dx	ln
4	nl	dx
5	nx	dl
6	lx	dn

The two forms that correspond to the original and combination 6 are given as an example in Fig. 71.

The combinations of threes are as follows:

	Unchanged.	Changed.
1	d	nlx
2	n	dlx
3	l	dnx
4	x	dln

In the combination of fours the whole four elements must be changed.

Naturally, in place of the shape given in the groups others may be used, since for any single dimension different values may be assumed; for example, in the combination of twos the value for the flare in No. 6 may be $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{12}$, $\frac{1}{40}$, etc., corresponding to the diameter of the waist. The same course can be taken with the length l, the nozzle distance x, etc. We can see that a given vacuum can be obtained with a number of different shapes of stacks.

This is, consequently, not at in harmony with the opinion expressed by Clark (to be sure, it referred to cylindrical stacks only); that, "for a given locomotive there was but one form of stack in which the efficiency would be greatest, but in spite of the fact that Nozo and Geoffroy corroborated him and Zenner and Prussmann applied the same principle to conical stacks we are confirmed in the opinion that:

On any locomotive with a given diameter of nozzle the same height of vacuum can be maintained with different stacks; the form itself, whether cylindrical or conical, being a matter of no importance.

The stack which will give the best results from the standpoints of the blowing of the fire and the consumption of coal cannot be determined either theoretically or by experiments with the apparatus; and here actual service on the locomotives must step in and play its part. This alone can tell us what stack will cause the fire to burn most evenly and quietly and give the smallest production of cinders and sparks. In general, a large stack is to be preferred to a small one for the production of a given draft, since with it, as we have already shown, the sides of the smokebox and the tubes remain cleaner, and also because it appears to be less sensitive in its influence upon the draft for slight changes in the position of the nozzle than is the case with smaller stacks.

In order to show the relative equality of the conical and cylindrical stacks in reference to their influence upon the draft, as well as the necessary differences in diameter the accompanying Table XXVII., based upon the curves given in Plate I., has been drawn up. It comprises those stack diameters, which, with nozzle distances ranging from 18.9 inches to 26 inches and the five different nozzle diameters (3.94 inches to 5.51 inches), produce the same vacuum of from 3.35 inches to 3.94 inches of water with a pressure of 3.94 inches of mercury in the experimental apparatus.

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen.*

TABLE XXVII.

Vacuum in inches of water.	Nozzle distance and shape of stack.		Smallest diameter of stack in inches which, with the same nozzle distance on the experimental apparatus, will produce the vacuum indicated with a nozzle diameter of				
	Inches.		3.94 in.	4.33 in.	4.74 in.	5.12 in.	5.51 in.
3.35......	18 90 ..	$\frac{1}{6}$	13.00	13.90	14.80	15.43	15.83
		$\frac{1}{12}$..................	14.53	15 36	16.26	16.73	17.13
		cylindrical.....	15 98	17 01	17.99	18 50	18.90
3.54......	20 47....	$\frac{1}{6}$..................	12 91	13.82	14.76	15.36	15.75
		$\frac{1}{12}$..................	14.33	15.20	16·06	16.58	16 97
		cylindrical ...	15.51	16.58	17.60	18.07	16.47
3.74.....	22.05....	$\frac{1}{6}$..................	12 81	13.78	14.69	15 28	15.67
		$\frac{1}{12}$....	14·10	15 (0	15.91	16.42	16.81
		cylindrical	14 92	16.10	17.13	17.64	17.95
3.94	23.62....	$\frac{1}{6}$..................	12.76	13.70	14.65	15.24	15.63
		$\frac{1}{12}$............. .	13.86	14 76	15.75	16.26	16.65
		cylindrical..... .	14.21	15.55	16.69	17.20	17.48

From this we may obtain for example the equivalent stack diameter of 4.33 inches and a distance of 20.47 inches and find them to be:

For the cylindrical.... ....16.58 inches.
For the conical with $\frac{1}{6}$ flare.... ....13.82 inches.
For the conical with $\frac{1}{12}$ flare.................. .. ..15.20 inches

The table shows that the cylindrical stack for experiments on the apparatus, or the basis of this relationship, according to the nozzle distance required and the vacuum to be produced must, in this instance, be made 2.76 inches larger than the waist of a stack with $\frac{1}{6}$ flare and 1.38 inches larger than that with a flare of $\frac{1}{12}$. Hence we conclude:

The less a stack opens out toward the top, by just so much more, for the same length, must its smallest diameter be made, if a draft of the same intensity is to be maintained.

If, therefore, it is desired to apply a stack to a locomotive that shall have the same effect upon the draft, but whose flare shall be different, while the length remains the same, the size of the diameter must vary and, inversely, if the diameter of the smallest section is to be left unchanged there must be a variation of the length.

For the sake of a practical demonstration a four-coupled eight-wheeled Erfurt express locomotive was tested with the same nozzle ratios and stacks of different diameters and flares as well as with cylindrical stacks of 15.75 inches and 18.7 inches in diameter. The length l was made to vary 23.62 inches and the diameter of the waist by 3.94 inches. They all steamed very well and permitted a heavily laden fast train to be hauled promptly on schedule time. The coal consumption and the production of sparks was naturally different. Accurate measurements showed that the cylindrical stack was large enough and yet it was no larger than the conical and was even smaller. Experiments were also made with cylindrical stacks on a locomotive of another make. Everything went to confirm the first results obtained on the apparatus, namely:

The conical stack is in no way superior to the cylindrical.

If Zenner and Grove arrive at a theoretical conclusion the opposite of this, it may be remarked that in their principal equation referring to it:

$$\frac{L}{D}\sqrt{\frac{\frac{fs}{fb}-c}{\mu\left(\frac{fs}{fr}\right)^2+e}}$$

the value of c, which expresses the conicity and shape of the stack, and is,

$$C=\frac{1+\left(\frac{fs}{fa}\right)^2}{2},$$

was an entirely mistaken one by them, owing to the lack of experimental data at that time.

In both of these equations:

L = the quantity of air, which is drawn in by
D = the quantity of steam blowing out of the nozzle.
fs = the smallest sectional area of the stack.
fa = " largest " " " " "
fb = " sectional area of the nozzle.
fr = " " " " " tube.
μ = a coefficient.

Both of these theoretical investigators now deduce from the foregoing formula:

The draft-producing efficiency of a stack increases as c becomes smaller; that is correct. But they also conclude c will be largest (fs remaining unchanged), for $fa = fs$, that is to say, for cylindrical stacks, and then $c = 1$; c will be smaller as fa increases, and it will be smallest ($= \frac{1}{2}$) for $fa = \infty$, that is to say for a stack the top of which has been widened out into infinity; from which it must be concluded that the more the stack widens out toward the top, by just that much will the effect upon the draft be more efficient. But this latter position is, as we have already shown, utterly untenable.

According to the Hanover experiments, as shown in Section VI., we find, on the contrary, the opposite to be the case, that is to say: *The smallest cross section of a stack remaining the same, the sharper a stack flares open toward the top (see Fig. 72) the less will be its effective action upon the draft.*

Hence the foregoing equation:

$$C=\frac{1+\left(\frac{fs}{fa}\right)^2}{2}$$

should be understood as follows: It is not fs but rather fa that must remain unchanged. Then the smaller fs becomes relatively to fa, by just so much will C also become less, and the effective action upon the draft increased.

The smallest value of C corresponds to $fs = 0$, in whch $C = \frac{1}{2}$, in accordance with the reasonings of Zeuner and Grove; but it has merely a theoretical significance.

When $fs = fa$ (a cylindrical stack) the maximum value of $e = 1$ is that at which the smallest value is obtained for the vacuum.

When $fs < fa$ (a conical stack) the result is a lower value for c and a greater one for L.

This corresponds exactly with the results of the Hanover experiments (Section VI. b) which showed:

The upper diameter of a stack remaining thus unchanged, the

Fig. 72

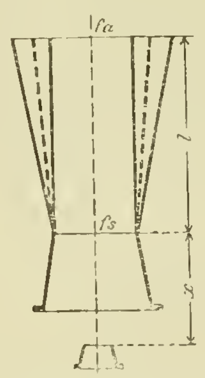


Fig. 73

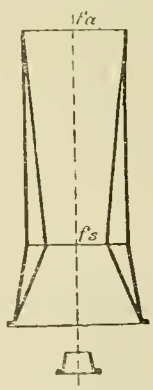
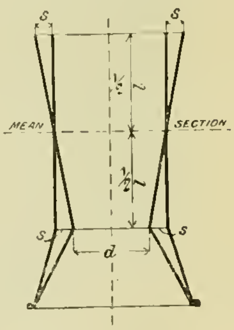


Fig. 74



sharper a stack contracts towards the bottom (see Fig. 73) by just so much, other conditions being the same, does the vacuum increase, in other words: *With the same diameter at the top the cylindrical stack is least effective as a draft producer.*

If the conical stack of Fig. 73 had the correct dimensions, the cylindrical stack of this figure for the same locomotive would naturally be too large, the nozzle relations remaining unchanged. If, on the other hand, the dimensions of the cylindrical stack were correct, then the conical stack that is indicated would be too small.

The above formula is therefore not available for making a comparison between conical and cylindrical stacks, and the many deductions made from it are unreliable. It simply asserts that generally a small stack produces a higher vacuum than a large one. The length of the stack and the position of the nozzle are not taken into consideration. Suppose a cylindrical stack with a sectional area fa (Fig. 73) produces too small a vacuum, the difficulty can be remedied without any change in the nozzle position, either by using a conical stack with a sectional area fa at the top, and whose smallest sectional area $fs < fa$, or by using a smaller cylindrical stack whose sectional area lies between fs and fa.

If it is desired to replace a cylindrical stack by a conical one, while the nozzle position and the draft is kept the same, it will be necessary, according to the experiments made on the four-coupled express locomotive, to keep the average sectional area of the two stacks the same; that is to say, we must make the upper diameter as much larger as the lower is contracted, as shown in Fig. 74. This, is, of course, on the supposition that the length above the base of the stack is to have a constant value l', which is the proper one for the sectional area of the tubes and the grate of the locomotive, and also with reference to d, as will be further explained later on.

As we have already explained, the experimental cylindrical stack with a length of 3 feet 4.02 inches under fixed relations is 3.19 inches larger in diameter than the waist of the stack, having a flare of $\frac{1}{6}$. This difference, according to the last table, becomes less the higher the vacuum; while, on the other hand, it increases as the nozzle distance is decreased, the height of the vacuum remaining the same.

Suppose we take, for example, a difference of 3.15 inches (80 millimeters), then, according to the comparison made below, with l^1 = 3 feet, 1.80 inch, the stack with a flare of one-sixth must be 3.15 inches, and that with one-eighth flare must be 2.36 inches smaller at the waist than a cylindrical stack of the same length l^1. Referring to figure 74, the size of *s* then becomes for

Stack with one-sixth flare = 1.575 inches.
" " one-eighth " = 1.18 "

In consequence of the foregoing equivalence of the cylindrical and conical stacks, the rule which has, up to this time, been accepted as correct, according to which a conical stack requires a larger blast-nozzle than a properly designed cylindrical stack, this rule, we say, has no longer any basis of support.

Both forms of stack, if properly designed, need the same diameter of nozzle for the production of the same draft.

Practical tests were made of this proposition on two standard express locomotives, with four wheels coupled, as well as on several compound and ordinary freight locomotives, and also on several tank locomotives, and in all cases the conical stack was replaced by the cylindrical without any contraction of the nozzle.

The steam production, the formation of sparks, the coal consumption, etc., was such, during a long run in actual service, that the drivers who were in charge were so well satisfied with the results that they never expressed a wish during the whole time to have the conical stack replaced.

XII. THE RULES OBTAINED.

The Grove rules* for the determination of the stack diameters depends entirely upon the sectional area of the tubes and ignores the grate area. This method of calculation was accurate for the locomotives of that time, but it is not applicable to the locomotives of to-day with their large grate areas. The stack diameters must rather be based upon both of these dimensions, as Clark has already pointed out in his time. As we well know, the ratio of heating surface to grate area varies considerably in practice.

Long boilers of the same or of similar construction frequently have different sizes of fireboxes, so that, in such cases with the same number and size of tubes, the grate areas may be of very different sizes. Hence, if it were allowable to settle the size of the stack with reference to the sectional area of the tubes only, locomotives, which might have widely different grate areas, would still have the same size of stack with the same nozzle opening. But this is practically unallowable. for it has been shown in locomotive service that large grate areas, under exactly the same conditions, need a lower vacuum and a larger stack than the smaller grate areas.†

The rules for the determination of the size of the stack must, therefore, take the grate area into consideration. *There are two ways in which this can be done:* Either we can calculate the diameter of the nozzle opening from the given sectional area of the tubes and the grate area, and then from this, by means of a corresponding ratio, determine the diameter of the stack, or we can calculate the latter directly from the grate area and the sectional area of the tubes, and then derive from it the proper diameter of the nozzle that is to be used. Both methods lead us to the same goal, but we prefer the latter.

For the sake of simplicity we show the method with which the grate area is taken into consideration and how a different value must be given to the co-efficient according to its size and which expresses the relationship existing between the sectional area of the stack and the tubes that must also be taken into account in the calculation. For example, suppose the grate area increase from 9.76 square feet (one square meter) to 26.9 square feet (2.5 square meters, this co-efficient, according to the experiments that have been made) rises from nearly .34 to .375 for conical stacks having a flare of one-sixth, while for cylindrical stacks it rises from .505 to .5625.

(*To be continued.*)

* The rule for hard coal firing is:
Sectional area of cylindrical stack = .50*fs*.
" " " waist of conical stack = .33*fs*.
Nozzle diameter for cylindrical stack = $\frac{1}{33}fs$.
" " " conical stack = $\frac{1}{20}fs$.
When *fs* indicate the seectional area of the tubes.
The flare of the conical stack equal $\frac{1}{6}$, $\frac{1}{8}$.

† A four-coupled compound locomotive of the Prussian State Railway, having a grate area of 24.4 square feet would, while hauling a heavy freight train weighing 183 gross tons at a speed of 50 miles per hour, maintain a vacuum of from 3.15 inches to 3.54 inches of water while cutting off at .43 of the stroke.

The Moskowitz System of Electric Car Lighting.

The National Electric Car Lighting Company, of New York, has a car on the Pennsylvania Railroad equipped with the Moskowitz system of car lighting, the patents on which are controlled by them, and is about to equip a chair car on the Santa Fe road for service between Chicago and Kansas City.

The system is an electric one in which the current is obtained from a dynamo driven from the axle. In the standard equipment of the company a 21-inch wooden split pulley is clamped onto the axle, and this is belted to a 7-inch pulley on a countershaft secured to the face of the truck transom. This countershaft is supported on "spring-cushioned" bearings, or bearings on which springs act in such a manner as to keep the belt tight when the journal boxes move up or down in the pedestals. From the countershaft another belt runs over an 8-inch pulley to a 4-inch pulley on the armature shaft of the dynamo, the latter being secured to the end piece of the truck frame. The split pulley is of specially prepared hard wood; the belts are double thickness, the one between the axle and countershaft being 6 inches wide and the other 3 inches, and both belts are specially prepared with a view of withstanding all sorts of weather, including snow and ice; the dynamo is encased in a steel cylinder that is dust and water proof, and all bearings are of durable metal and automatically oiled from cups or reservoirs that will hold a week's supply of lubricant. The dynamo weighs 300 pounds, the split pulley on the axle 35 pounds, and the countershaft complete 80 pounds.

The dynamo is so wound that it maintains a practically constant voltage at all speeds above eight miles per hour, there being an increase of only three volts between this speed and 60 miles per hour. The poles are automatically reversed with each reversal of the direction in which the car moves, this being accomplished by devices on the switchboard.

The dynamo does not generate electricity at speeds below eight miles per hour, and to keep the lights going at times when the car is standing or running slow, two sets of storage batteries are provided, one set charged and ready to be automatically thrown into the light circuit when the speed falls below eight miles per hour, and the other being charged by surplus current generated by the dynamo. When fully charged the second battery is switched into the light circuit and the first one is connected to the dynamo for recharging.

The standard equipment for a 60-foot passenger car consists of fourteen 16 candle-power lamps, twelve in the body of the car and one in each vestibule. The current is taken from the dynamos on the truck by flexible connections to the car body and thence to a switchboard located at any convenient point, preferably in one of the closets in the car. The board is boxed up and can be put under lock and key if desired. On the switchboard are grouped all the devices by which the entire apparatus is controlled. First, there is the main switch, which controls all the dynamo circuits and which must be closed in order that the dynamo may generate a current. An ammeter shows the quantity of current generated and a resistance coil is provided to be switched into the light circuit if needed. Then there are the automatic electro-magnetic devices for reversing the polarity in the dynamo, already mentioned. There is also a special 12-point switch which controls the whole system. It is connected with the two sets of storage batteries already mentioned. While one of these batteries is furnishing light the other is being charged from the dynamo. When the battery that is furnishing the light is exhausted, the switch is thrown to the opposite position, and thereby connects the battery that has just been charged with the lights, while the other is connected with the dynamo to be charged again. One turn of the switch accomplishes the two changes, and it is impossible to make a mistake.

The storage batteries are carried in two wooden boxes under the car, and it is claimed that they require looking after only once in several months.

It will thus be seen that the system comprises the dynamo, two sets of storage batteries, a light circuit, and a switchboard. A car is supposed to start after installation of the system with its batteries charged sufficiently for six hours' light, and should then have current at all times for lighting purposes.

The chief claims made for the system are: A high grade of efficiency at moderate first cost, simplicity of design, ease of inspection, small operating expense, and the possibility of employing unskilled labor for attendance. The simplicity of operation is evident when it is considered that there are but two switches to operate, one throwing the dynamo into or out of service, and the other changing the connections to the batteries. All other features are automatic.

The National Electric Car Lighting Company has offices at 30 Broad street, New York City.

New Publications.

THE CHICAGO MAIN DRAINAGE CHANNEL. A description of the Machinery Used and Methods of Work Adopted in excavating the the 28-mile Drainage Canal from Chicago to Lockport, Ill. By Chas. S. Hill, C. E., Associate Editor *Engineering News*. The Engineering News Publishing Company, New York, 1896. 129 pp., 8 inches by 11 inches.

The drainage canal which the city of Chicago is constructing is one of the greatest works of its kind in the world, and the policy of letting the excavation of the 40,000,000 cubic yards of earth and rock in small sections, combined with the variety of the materials to be excavated, has resulted in the employment of many methods for handling the material. Engineers expert in this kind of work have everywhere praised many of the methods devised and employed successfully by contractors who previously had little actual practice in canal work. Hence the volume before us is of special interest and value, for it describes and illustrates the methods and machinery employed. The cost of excavation are also given whenever obtainable, and while contractors would not in all cases furnish cost figures, the author believes that this volume contains more complete figures of the work than exist anywhere outside of the official records of the canal engineers. The book contains 100 excellent engravings and is written in a clear and concise style. It is a reprint of a series of articles which appeared in *Engineering News* last year, but numerous additions and revisions bring the work up to date. In an appendix the effect of the completed canal on the lake levels is fully discussed. We heartily commend the book to the attention of our readers.

LOCOMOTIVE MECHANISM AND ENGINEERING. With an Appendix on the modern electric locomotive. By H. C Reagan, Jr., Locomotive Engineer. Second edition. John Wiley & Sons, New York. Chapman & Hall, Limited, London. 1896. 419 pages. 5 inches by 7 inches.

This book undoubtedly contains information of value to locomotive engineers and firemen, but the style of the author is far from clear, and what he says, if taken literally, would sometimes be misleading and even absurd. For instance, on page 2 he says: "That portion of boiler which is over the firebox must be very strongly stayed with either crown bars or radial stays. . . . This staying is necessary from the large area and the exposure to the hottest part of the fire." Neither of these reasons is true. Certain parts of boilers are stayed because their shape or form is such as to require it. On page 5 is the following: "It is important that all gage-cocks should be kept open and especially, under all circumstances, the lower one." What the author evidently means is that gage-cocks should not be allowed to become clogged up, but he does not say so. On the contrary, he appears at first sight to advocate the practice of running an engine with the gage-cocks wide open. On the same page the explanation of why the use of wet steam should be avoided could be considerably improved in clearness and accuracy. We might quote many other cases of bad English, such as where the author calls pistons "round disks,", etc., and of misstatements, such as where it is said on page 73 that "cushion" in a cylinder is required "to prevent the piston head from striking the cylinder head"; but it is not necessary to go through its 419 pages to indicate the character of the work. In general, it may be said that the author appears to have a good fund of practical knowledge, but he is not sufficiently grounded in the principles of locomotive engineering to be always accurate; and furthermore, that his command of language is not sufficient to enable him to say just what he means in all cases.

EXPERIMENTS UPON THE CONTRACTION OF THE LIQUID VEIN ISSUING FROM AN ORIFICE, AND UPON THE DISTRIBUTION OF VELOCITIES WITHIN IT. By H. Bazin, Inspector Général des Ponts et Chaussées. Translated by John C. Trautwine, Jr. John Wiley & Sons, New York; Chapman & Hall, Limited, London, 1896. 64 pages, 5¾ inches by 9 inches.

This book records the results of very accurate experiments made upon liquid veins by the author, at Dijon, beginning in 1890. The orifices were as follows; 1. Orifices in a vertical plane: Square orifice, 0.20 meter square (contraction complete); circular orifice, 0.20 meter in diameter (contraction complete); rectangular orifice, 0.80 meter wide by 0.20 meter high (lateral contraction suppressed). 2. Orifices in a horizontal plane: Circular orifice, 0.20 meter in diameter (contraction complete); circular orifice, 0.10 meter in diameter (contraction complete). The co-efficients of discharge, the geometrical figures of the veins and the velocities in the interiors of the veins, were determined for each of these orifices, under a head of 0.95 meters. Many valuable figures are given and the more important conclusions may be briefly stated as follows: The experiments do not show the presence of a minimum section in the contracted vein. The vein contracts rapidly at first and then more slowly as its distance from the orifice increases. The minimum velocity at the orifice is at the center for orifices in a horizontal plane and a little above the center of gravity of the section for orifices in vertical planes. As the distance from the orifice increases the velocities in the flow from a horizontal circular orifice equalize rapidly; in the flow from a vertical orifice the minimum in the central region soon disappears, but the velocities in the lower part of the vein remain greater than those in the upper part. In the expression $U = K\sqrt{2g(h + y)}$, U representing the velocity and y the fall of the center of the section below that of the orifice, the co-efficient K is slightly less than unity for a horizontal orifice and more than unity for a vertical one. It might attain a value of 1.03 or 1.04 for vertical orifices.

The volume is a most valuable addition to the literature of hydraulics, and the reputation of the author is a guarantee of the accuracy of the work, for his name is already known to English-speaking engineers through his valuable experiments on the flow of water in open channels.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

LIST OF GEARING, PULLEYS, SHEAVES, ETC. Robert Poole & Son Company, Engineers and Founders, Baltimore. Md., U. S. A., 1896. 234 pages. 5 by 7½ inches. (Not standard size.)

As its title indicates, this book is a list of gears, pulleys, etc., for which the Robert Poole & Son Company have paterns, and which they can therefore furnish on short notice. The patterns are classified according to pitch and the tables give all the essential dimensions of each gear and pulley. The list includes spur, level and mitre gears of many sizes; mortise gears, spur, face and bevel; worms and worm gears; wheels for wire-rope transmission; sheaves for ropes and chains; band, rope and fly wheels; and pulleys for belt transmission. While the list of gears contains only the sizes for which the company has patterns, the system of machine-molding employed at their works enables them to make almost anything in the gear line of one inch pitch or over, with but little expense for preparation. The reputation of this company's machine-molded gears is thoroughly established and not the least of their merits is the excellent material put into them. The company's facilities enable them to make gears up to 50 feet in diameter. The company also has facilities for making cut gears of all kinds up to the same size. This concern makes the Poole-Leffel double-turbine water-wheel, patent friction clutches, shaft hangers, thrust bearings, etc., all of which are illustrated in this catalogue, though some of them are more fully described in other pamphlets issued by the company.

THE MOST ECONOMICAL BRAKESHOE. The Schoen Brakeshoe Company, Betz Building, Philadelphia, Pa. 8 pages. 6 by 9 inches. (Standard size.)

This pamphlet illustrates and sets forth the advantages of the pressed-steel brakeshoes made by the company. The tests of the brakeshoe committee of the Master Car Builders' Association are quoted to show that soft pressed-steel shoes rate very highly in their wearing qualities and holding power. They are claimed to wear 10 times longer than cast-iron shoes, to be capable of being worn thinner, thus giving more useful wearing material per shoe, to hold with a nearly uniform retarding power, to heat less rapidly than other shoes, to necessitate less frequent adjustment of the brakes, to wear the wheels less than cast-iron shoes, and to effect a saving of from 50 to 75 per cent. in the outlay required for brakeshoes. To substantiate these claims the company can point to the experience gained in three years of service. The shoes are made by hydraulic pressure by a process that permits the use of very soft steel, and the form and dimensions of the present standards are duplicated with great exactness.

WATERMAN'S IDEAL FOUNTAIN PEN. L. E. Waterman Company, 155-157 Broadway, New York. 16 pages. 5 by 6¼ inches.

This catalogue illustrates the various sizes and styles in which this, the best of fountain pens, is made. It contains many testimonials as to its excellence, beginning with the opinion held by Mr. Chauncey M. Depew, who says: "I am still using your incomparable fountain pen. Since I bought my first one in July, 1886, it has been my constant and faithful companion." We would take this opportunity to add our testimony to that of others who have used this excellent pen. We have now used this pen for four years, and in all that time it has never failed us. It has always made its mark on the first stroke and given no trouble in feeding. To those who have had trouble with fountain pens that won't feed or that feed too much, we would advise a trial of the Waterman. With the most ordinary care they will be found always ready and will always write smoothly.

The Fourth Annnal Report of the Michigan Peninsular Car Company.

The fourth annual report of the Michigan Peninsular Car Company, of Detroit, is an interesting document. This large concern, formed by a consolidation of several interests four years ago, has a plant comprised of two complete car-building establishments, one car-wheel foundry, a forge and iron works, and a pipe plant, the total valuation being $7,720,536. The report shows that durtng the year the company spent $24,478, in additions to its plant, and that its total assets on Aug. 31, 1896, was $10,429,791.49. The preferred capital stock is $5,000,000, common stock $3,000,000 (of which $1,000,000 is unissued) and there are first mortgage bonds to the extent of $2,000,000.

During the year ending Aug. 31, 1896, the company paid the interest on the bonds and also dividends of $200,000 on the preferred stock, and then had a surplus on the year's business of $96,571.84. Like that of all other manufacturing concerns its business for the last four years shows great fluctuations. The figures prove, however, that the plant of the company can be operated with good profits when work is obtainable to keep it going, as is evident from the following statement of earnings from all sources for the four years commencing Sept. 1, 1892, and ending Aug. 31, 1896:

1st year	$866,690.66
2d year	30,024.38
3d year	159,231.98
4th year	395,571.84
Total	$1,458,517.86

During the first year of this period the company paid $400,000 dividends (8 per cent.) on the preferred stock and $160,000 on the common stock. Of course, with the depressed condition of business in the second and third years, the earnings did not suffice to pay the interest on the bonds, but in the last year dividends have been resumed and the company stands ready, with a large and efficient plant and considerably more than a quarter of a million surplus, to take advantage of the improvement in business to be expected after the election has given business men the assurance of a sound currency.

Graphite Paint for Metal Work

Engineers are giving much more attention now than formerly to the paints employed in the preservation of structural iron and steel from corrosion. Undoubtedly the large use of steel in fireproof buildings where it is not accessible after the buildings are complete has been an important factor in stirring up this interest. The protection of such surfaces from corrosion is certainly a matter of moment. It is of vital importance in the case of fireproof buildings, and in all structures a suitable protective coating is a source of economy. Roofs and bridges, while accessible for re-painting, are made more durable at less expense by a coating that is lasting and does its work thoroughly than by one that needs frequent renewal. In our article on steel cars in France, published in our August issue, it was shown that the protection of a good paint applied frequently enough to keep the surface covered at all times added many years to the life of the cars. And so many other cases might be cited which in part explain the present interest in protective paints for iron and steel.

The possible chemical action between the pigment and the oil, and its effect upon the surface it covers have been studied carefully and the opinion is now held that some paints actually promote oxidation of the metal. But however truly this may apply to some paints it is not true of all them, and those known as graphite paints are certainly free from any tendency to chemical action between their constituents, and show remarkable resistance to chemical action from without. "Superior" graphite paint manufactured by the Detroit Graphite Manufacturing Company, of Detroit, Michigan, has established itself in the confidence of engineers by the excellent record it has given in actual service. The graphite entering into this paint is mined by the company in Northern Michigan. Mixed with an oil and free from acids, it is chemically inert, and in drying forms a coat that adheres firmly to the metal surface. Its resistance to the action of acids and alkalis has been proven by numerous tests much more severe than the conditions of service, and its resistance to the penetration of moisture have been equally satisfactory. Heat does not cause it to blister, and we are informed that steel chimneys painted with it have been heated to redness without affecting the paint. The viaduct by which the Canadian Pacific and Wabash roads enter Detroit is painted with "Superior" graphite paint, and after two years service is still in excellent condition. A fire in neighboring flour sheds played upon the iron-work for two and one-half hours without blistering the paint, This fact is attested by Mr. J. E. Smith, superintendent of terminals. who in the same letter also says that the smoke and fumes from Michigan Central locomotives, which pass under the viaduct at one point, have had no effect upon the paint.

The paint has been used with success upon the hulls and decks of steel steamers, and there seems to be no conditions of service which it does not successfully meet. Those who would use it in places where its natural color is undesirable, can have a choice of several colors and shades. The Detroit Graphite Manufacturing Company use every care in the manufacture of the paint. The fineness of its particles give it excellent covering qualities and cause it to apply evenly.

A Commercial Travelers' Fair.

A commercial travelers' fair is to be held in Madison Square Garden, New York, Dec. 15 to 28. Its aim is to raise $150,000 to complete the National Home for commercial travelers or their dependent families, at Binghamton, N. Y. It is the intention of those in charge to make the fair one of the best attractions of the year. Mayor George E. Green, of Binghamton, is President of the Commercial Travelers' Home Association, and is the Treasurer of the fair. Col. A. B. de Freece, Director-General of the fair, has proposed that upon Tuesday, Dec. 1, in every city of more than 10,000 inhabitants, the hotels, theatres and leading stores will devote a percentage of the day's receipts to the Fair Home building fund. Mr. Allen S. Williams has been elected Chairman of the Commercial Travelers' Day Committee. The Honorary Committee of the fair, which is presided over by the Hon. Chauncey M. Depew, comprises over 1,200 leading men in the United States, representing almost every principal locality important in traffic, producing or manufacturing. The only detail necessary to the perfect working of the plan for a Commercial Travelers' Day (which is to be a feature of the fair) is for the hotels, theaters and stores desiring to share in the philanthropy, honor and pecuniary benefit of the occasion to promptly notify Chairman Allen S. Williams at Madison Square Garden, New York, of their desire to remit the cash results on Dec. 2, in a New York bank draft payable to George E. Green, Treasurer, or to Director General A. B. de Freece at Madison Square Garden, New York.

Wm. Skinner & Son, of Baltimore. have received an order from the Baltimore & Ohio for 10 freight lighters for use in New York Harbor.

The American Brake Beam Company has orders for 4,000 Kewanee beams for the Erie cars being built by the Michigan-Peninsular Company.

The Niles Tool Works has an order from the Government for eight carriages for 10-inch disappearing guns. This equipment is for coast defense.

The Lidgerwood Manufacturing Company, 96 Liberty street, New York City, has opened a branch office at New Orleans in the Hennen Building, in charge of J. H. Dickinson.

The report that the plant of the Cambria Iron Company, at Johnstown, Pa., had closed for an indefinite period is denied. The plant resumed operations on the 12th of last month.

The West Shore Railroad has placed a contract with the Harlan & Hollingsworth Company, of Wilmington, Del., for a steel hull ferryboat for use on the North River. The boat is to be 250 feet long.

Mr. C. R. Brown, formerly with the Illinois Steel Company, has entered the Western department of the Lappin Brake Shoe Company, and has offices with Mr. F. P. Collier, the Western Manager for the company, in the Rookery Building, Chicago.

Prince Hilkoff, Russian Minister of Ways and Communication, who has been in this country studying American railroad operation, has sailed for Europe. It is said that before sailing he placed orders for 18,000 American watches for the use of the trainmen on Russian railways.

At the last meeting of the Board of Directors of the Bloomsburg Car Manufacturing Company, Bloomsburg, Pa., a change in the Presidency was made, Mr. G. M. Lockard having sold his interest in the company to Mr. L. S. Wintersteen. The latter gentleman was made President. The works are at present busy filling orders for Japan and South America.

The Bloomsburg Manufacturing Company, Bloomsburg, Pa., had a part of its main building blown down in the severe storm of Oct. 1, and the roofs of the boiler-house and muffle-room carried away. Rebuilding and repairs were at once commenced and now the mill is in full operation.

The Shoenberger Steel Company, of Pittsburgh, has awarded contracts to the Ball Engine Company, Erie, Pa., and to the Siemens-Halske Electric Company, New York, for an electric power plant, consisting of one 400 and one 150 horse-power vertical compound engine, direct connected to 225 kilowatt and 100 kilowatt generators.

George P. Nichols and Brothers, 1325 Monadnock Building, Chicago, announce their appointment as general sales agents for the Western States of the J. H. McEwen Manufacturing Company, of Ridgway, Pa., manufacturers of the McEwen automatic engine, simple and compound; also the Thompson-Ryan generator for electric railway, power and lighting plants, belted and direct connected.

Messrs. Riehle Bros. Testing Machine Company have shipped to the Sormovo Co., Nijni Novgorod, Russia, a 100,000-pound automatic and autographic testing machine and also a specimen miller. They have also placed 200,000-pound testing machines at the works of the Schoen Pressed Steel Company and Jones & Laughlins, Pittsburg. They are also building a large 300,000-pound wire rope testing machine for John A. Roebling's Sons Co , Trenton, N. J.

The American Stoker Company, of Dayton, O., has recently perfected a steam motor which is applied to each stoker, thus making each machine independent. This renders the work of installation very simple. It also renders the stoker practicable for use under Marine boilers. This company is desirous of a general representation through engineering firms handling pumps, heaters and boiler-room supplies, and invites correspondence from interested parties.

The Ingersoll-Sergeant Drill Co. have placed an air-compressor in the engine-room of the Havemeyer Building, New York City, and compressed air will be supplied to tenants in the building who desire it. The company's offices are in this building and it will employ air to operate appliances of all kinds on exhibition in its offices. This will include machinery, tools, letter-presses, etc., while the same agent will be used to dust the furniture, clean carpets, ring call-bells, open doors and in general display its usefulness and utility.

The Peerless Rubber Manufacturing Company of New York has added a 320 by 40 feet extension to its works. The building is three stories high and practically doubles the capacity of the plant. The capacity of the Peerless plant is now $2,000,000 worth of mechanical rubber goods per annum. In the new factory are four 200 horse power of water tube boilers and one 500 horse power Corliss engine. Among other machinery it contains one of the largest belt presses in the world, it being 30 feet long, 60 inches wide, with double plates and double stretchers.

The Borden & Selleck Company, Lake street, Chicago, Ill., reports a fairly active business in its coal and ash handling machinery. Among plants recently put in operation are: Ash and soft coal handling conveyors for two power-houses of North Shore Electric Company (Chicago); soft coal conveyors, steel storage tanks, etc., for carrying coal from a side-track through a tunnel under street and factory, delivering same into battery of boilers, for Jas S. Kirk & Company, soap makers, Chicago. A contract has just been closed with the Chicago Public Library for anthracite coal and ash-handling machinery for the new library building.

Notwithstanding the dull times the New York Belting and Packing Company has within the last few weeks taken orders for interlocking rubber tiling for three prominent hotels in New York City, a well-known club in Cincinnati, 32 dining and sleeping cars, one steamship and one United States battleship. The first lot of tiling the company laid was in the Broad Street Depot of the Pennsylvania Railroad, in Philadelphia. After two and one-half years of wear, with an average of 50,000 people passing over it each day, the tiling has worn down only one-sixteenth inch, and that only in spots where most of the travel is concentrated. Not a cent has been spent for repairs since it was laid. We saw this tiling less than a week ago and it was noticeable for its freshness of color and perfect condition generally. The tiling is remarkably pleasing in appearance when new and loses none of that attractiveness as it wears. It gives a good foothold, does not wear slippery, and, in fact, it retains all of its good qualities unimpared throughout its life. It should be investigated by those who desire a durable and artistic covering for floors, stair landings, decks, etc.

Florida and Western North Carolina.

The climate is nearer perfection than that of any other place on earth. The time is fast approaching when numbers will desire to seek a milder climate. Where shall you go? The Southern Railway, "Piedmont Air Line," the great Southern trunk line, offers numerous attractive resorts located upon and reached by this great system of railways, all reached from New York in Pullman's finest vestibuled trains, giving all the comfort and conveniences that are required by the demand of the traveling public. If you are contemplating a trip and want descriptive literature or any information regarding the winter resorts South, call on or address General Eastern Office of the Southern Railway, 271 Broadway, New York.

Our Directory

OF OFFICIAL CHANGES IN OCTOBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Altoona, Clearfield & Northern.—President F. G. Patterson has been appointed Receiver.

Brooklyn Beach.—Mr. E. L. Langford has been chosen President, vice J. Jourdan.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. Walter A. Scott has been appointed General Manager, with office at St. Paul, vice Mr. H. G. Bent, resigned.

Chicago & Northwestern.—Mr. Horace G. Bent has been appointed Third Vice-President, vice Mr. W. H. Newman, resigned.

Charleston & Western Carolina.—This corporation is the successor of the Port Royal & Augusta.

Interoceanic of Mexico.—Mr. G. M. Stewart has been appointed General Manager.

Illinois Central.—Mr. F. W. Brazier has been appointed Assistant Superintendent of Motive Power, with office in Chicago.

Louisville, Evansville & St. Louis.—Mr. J. F. Lechler has resigned as Master Mechanic at Princeton, Ind., and is succeeded by Mr. F. C. Cleaver. Mr. W. W. Wentz, Jr., is Secretary and Purchasing Agent, with office at Louisville.

Minneapolis & St. Louis.—Mr. Edwin Hawley has been chosen President, to succeed Mr. W. L. Bull, resigned.

Missouri, Kansas & Texas.—Mr. J. L. Wigton has been appointed Master Car Builder of lines north of Denison, with headquarters at Sedalia, Mo. Mr. W. H. Brehm has been appointed Master Mechanic over the same lines, with headquarters at Parsons, Kan.

Manitou Beach.—Mr. F. J. Sarnon, formerly Master Mechanic, has been made Superintendent, vice Mr. G. C. Mills. Mr. Chas Sarnon is appointed Master Mechanic.

Mexican National.—Mr. E. D. Stegall has been appointed Master Mechanic at Acambaros, Mex. Mr. E. W. Knapp, formerly at Acambaro, has been transferred to Mexico City.

Northampton & Hertford.—G. H. Clark, Jr., has been elected Vice-President, with office at Newark, N. J., vice A. L. Shepherd, deceased.

Norfolk & Western.—The Receivership was abolished Oct. 1. Mr. Henry Fink is President and Mr. F. J. Kimball Chairman of the Board of Directors.

New Orleans & Western.—Mr. W. Mason Smith has been chosen President, vice Mr. Chas. E. Levy, resigned. Mr. W. W. Pierce has been chosen Vice-President, vice Mr. W. Mason Smith.

Ogdensburg & Lake Champlain.—H. Walter Webb has been appointed Temporary Receiver.

Oregon Improvement.—Mr. L. H. Hawkins has been appointed Chief Engineer, with office at Seattle, Wash.

Pullman Palace Car Co.—Gen. Horace Porter, first Vice-President, has resigned, and is succeeded by Mr. G. H. Wickes, formerly second Vice-President.

Pittsburgh & Lake Erie.—Mr. J. A. Atwood has been appointed Chief Engineer.

Wheeling & Lake Erie.—Mr. W. H. Stark, Master Car Builder has resigned.

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

DECEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

VI.

(*Continued from page* 284.)

PIECE-WORK.

In nearly, or quite, all of the shops at Altoona, work is now done by piece-work, and almost all of it, even to such service as handling coal and ashes, cleaning the tubes of locomotives, washing windows, etc., has now been brought under that system. This was introduced at Altoona in a sort of rudimentary form as much as 25 years ago, and has been throughly tested and perfected since, and its great advantages have, it is thought by those who are in charge of the shops, been thoroughly demonstrated during that period, and they would as soon think of substituting the old hook valve-gear for the link-motion, or replacing injectors with pumps, or steel tires with those made of cast-iron, as of going back to the day-work system in their shops. Now, one of two things is certain, either those in charge of the machinery, the shops and the work at Altoona are very much deluded with reference to the advantages of that method of doing work, or those who are responsible for the management of other similar establishments are very blind in not adopting it, or, at least, acquainting themselves with the working and merits of that system.

It is claimed for it—and apparently on grounds which cannot be disputed—that it doubles the output of work from a given equipment and a given number of men. In proof of the latter it is said that in the old shops at Altoona, before work was done in this way, 50 new locomotives were built in a year. After piece-work was introduced 100 were built in the same time, with substantially the same tools and appliances and the same number of men. An equal increase has been made in the output of repair work in the locomotive and car shops.

As an illustration the following case was cited by one of the foremen: In 1880, in making the general repairs to locomotives, a gang of 32 men were employed for every three engines. By days-work it then took 28 days to rebuild three engines and the work in the erecting shop cost $270 per engine. When piece-work was first introduced 14 men and 2 apprentices were employed to do the same work and it cost 20 per cent. less. Now this work is done by 9 men, 3 apprentices and 1 laborer in 14 days and the labor costs $90 per engine.

In the construction of new engines the difference is equally as marked as in repair work. The cost of day's work in the erecting shops of what are known as class I engines was $290. Engines of the same general class, but about 15 tons heavier, now cost $95.75, and are done in half the time. Substantially the same equipment, such as traveling cranes was employed under both systems, although some appliances and methods for doing work economically were devised and adopted by the men and their foremen in order to facilitate and expedite what they were doing. By day's work it took three days to build a box-car; now it is done in 14 or 15 hours. The pipe-work on a locomotive formerly cost $137, and now costs $32.

In making up the schedule of prices for piece-work from the cost by the day's-work system a primary reduction of 25 per cent. was made. Since then other reductions in prices have followed, so that now, as has been stated, the cost of labor in the Pennsylvania shops has been reduced one-half, and the output of work by a given equipment and number of men has been doubled. If these statements have any basis of fact to rest upon, they are surely worthy of serious consideration by those who control similar expenditures in other great enterprises.

Another advantage is that the men make a great deal more money, in a given time, under the piece-work system than they do when working by day work; they are more interested in what they are doing, become more efficient in their duties and are better content in their positions. No driving of the men is required, because if any of them are disposed to loiter or "loaf"—as expressed in workshop vennacular—the time thus wasted is their own loss. To a great extent they can enjoy the independence of controlling their own time, and none excepting those who have endured it know how irksome it becomes in time to be tied down to fixed hours and inexorable conditions of service.

Another effect of the system is that it stimulates the ingenuity of the men to devise new methods and appliances for doing and handling work. They resort to all kinds of expedients to facilitate what they have to do and increase their output. This was especially noticeable in the blacksmith shop at the car works. In modern car construction many forgings of more or less complicated forms are required. To make these a great variety of formers, dies, clamps, etc., are needed, and each man who is paid for the number of pieces he can make in a day is interested in devising new appliances which will facilitate the doing of his work. A very interesting book might be written describing the means employed in this shop and showing how the different kinds of forgings are made.

It also results in a complete differentiation of capacity. That is if a man has any kind of special skill or apitude, he is employed only on work which requires such skill, while that which can be done by mechanics of a lower grade, or by ordinary laborers, is assigned to men of that class. In that way a process of specialization is instituted, which, to a great extent, becomes automatic in its action, so that each man does what he is best suited for. It also results in the speedy weeding out of the incapables and the unworthy.

If honestly and justly administered, it removes some of the chief causes of disputes between the men and their employers, and substitutes "sweet reasonableness" for contention and acrimony.

The first objection, which is made by those who have little or no knowledge or experience with the practical working of this system, is that it results in bad workmanship, and it is assumed that it is an utterly hopeless task to undertake to so classify all the multifarious operations required to repair locomotives or cars, as to be able to assign a fair price for each distinct operation. Some idea of the complexity of this task may be formed when it is said that in the locomotive erecting shops there are 180 seperate items and prices for stripping an old engine and 360 for erecting it anew. Besides locomotive work considerable is done in this shop on signals, water-stations etc,, for all of which there are separate scales of prices, making about 1,000 items in this one shop. In all the locomotive repair shops there are probably from fifteen to twenty thousand distinct prices and at the car and Juniata shops as many more. Only about one per cent. of the work in the erecting shops is done by days work. In the boiler shops there is a price assigned for putting in stay-bolts; riveted work is counted at so much per rivet, caulking and flanging is paid at a given price per foot.

The following are some of the items taken at random from the schedule of prices in the boiler shops, the prices themselves being omitted:

PATCHING BOILERS AND FIREBOXES.

Putting in cheek patches and other small patches with less than 20 rivets, per rivet...$
For larger patches in boilers and fireboxes—for first 30 rivets, per rivet.
All over 30 rivets in same patch, per rivet................................
Putting new bottom in smokebox 65 to 80 inches long..................

ASH-PAN REPAIRS.

General repairs to include new side sheets or sides straightened and patched, bottom straightened and patched, new shields, top and bottom, new collar pieces or collar straightened, one back plate, side pocket and lid straightened, new damper bearings.

Ash-pan cleaned and painted, classes J, K, P and R, each....................$
Flanging ash-pan collar..
" " damper..

Examining boiler and stays ...
" firebox and staybolts...
Cutting out old brace and fitting and riveting new one ...
Making new brace...
Cutting out old crow-foot and fitting new one...
Renewing bolts in sling stays; for the first 4 bolts each...
Over 4 bolts and up to 8...
All over 8 bolts...
Renewing stay bolts in erecting shop for first bolt...
For second bolt...
All additional up to 50...
All over 50 in same engine...
Riveting leaking stay-bolts...
Cutting out old back flue sheet and fitting in new one...
Chipping, riveting and caulking back flue sheet...
Caulking hot boiler in erecting shop...
Repairing fire door...
" " " and frame...
" " " catch...
" " " latch...

About 250 men are employed in the boiler shops and two clerks are required to keep the accounts. Here, too, the schedule of prices includes about 1,000 items.

In the repair of old cars and the construction of new ones piece-work is employed, as in all the other shops. Probably many of our readers entertain the same opinion that the writer did before investigating this subject which was that in the repair of cars there would be such a multiplicity of different defects and operations that it would be impracticable or impossible to make a schedule of prices covering all the work to be done. Experience has, however, shown that car disorders are analogous to the diseases of human beings. They are not all afflicted with the same ailments, but there are various kinds of infirmities from any one of which many people and many cars may suffer. The diseases of men, women, children and cars may all be reduced to classes and sub-classes, and the remedies are the same in all similar cases. This makes it possible by intelligently analyzing the repairs of cars, to make schedules of prices which will cover all the infirmities to which they are subject. Of course, making such a schedule and fixing rates which would be fair to both parties to the transaction was a task of gigantic proportion and could only be worked out by the exercise of the most intelligent and painstaking care and an unwavering disposition to do justice to both sides.

In the erection of new cars and the repair of old ones the men work in gangs of about ten, and the work done is credited to the gang and then divided up among the individuals who compose it. In all cases where work can be done to better advantage by the co-operation of a number of men this system is adopted. If men of different degrees of skill are employed on one job, as where helpers or laborers compose part of the gang, these get a smaller proportion of the earnings according to their rating.

The persons best able to judge of the efficiency of piece-work are the shop foremen. In going through the different departments careful inquiry of the men in charge of them was made with reference to this point. All were agreed that the amount of work turned out was immensely increased by piece-work, and the cost greatly reduced. This reduction was estimated by different foremen at from 33⅓ to 65 per cent. The information obtained in the car works confirmed what was learned in the locomotive department. If anything the increased output in car repairs and construction and the reduction in cost is greater than it is in the locomotive shops. Surely such facts as these cannot be disregarded by those in charge of railroads whose work is done under the old system of day labor. With the advantages which result from the adoption of the piece-work system before us, it would be just as reasonable to object to the use of locomotives because each one with its tender consists of over 12,000 or 15,000 separate prices, as it is to condemn the piece-work system because that number of pieces are required in doing work under it, or a man for a similar reason might object to wearing a pair of trousers because if they were unravelled they would consist of some thousand separate threads and perhaps millions of distinct fibers of wool. The fact is, as Herbert Spencer has explained, evolution is "from the homogeneous to the heterogeneous," and in highly developed enterprises complexity becomes unavoidable.

Undoubtedly the risk of bad workmanship under the piece-work system must be encountered, but for this an adequate and effective method and organization for the inspection of work is found to be a sufficient safeguard. The success of the system is dependent upon such inspection. Without it piece-work is as impracticable as civil government would be without a judicial department. The fact that skillful, honest and intelligent inspection is required in doing piece-work is no more valid objection to it than it would be to find fault with civil government, because the same characteristics are required in our courts and judges. It should be recognized at the outset that piece-work is impracticable without adequate inspection, and without it it will fail utterly. Great care, labor, integrity of purpose and patience in its organization and in formulating scales of prioes, in the classification of work and its general supervision, are required. It must be admitted that much more intelligent supervision is needed to introduce and maintain it successfully, than is demanded with the ordinary method of so much pay for so many days or hours of work. Any disposition on the part of those in charge of shops to deal unfairly with the system or "beat" the men, or to lower the prices so much that they cannot earn somewhat more than they can by days work. is certain to defeat itself. The piece-work system must be conducted justly, intelligently and impartially, and unless it is it is unworkable, and will fail. Do the results compensate for the employment of a much higher order of intelligence in its supervision?

One purpose of this article is to answer this question, and another will be to describe how the system has been introduced, how it works, and what the results are.

At first sight it may appear, as has been intimated, as though a subdivision of the multifarious operations involved in the construction and repair of locomotives into distinct operations, and assigning a price to each which will be fair and just under all the conditions which arise, would be utterly hopeless. That it is difficult to do this must be admitted, and that an enormous amount of labor, time, patience, knowledge, intelligence and integrity of purpose had to be expended in creating a system like that which now exists in the Altoona shops is also true. The magnitude and complexity of the undertaking will be indicated by an enumeration of some of the different trades and occupations in which the employees are engaged. Among these are machinists, blacksmiths, boiler-makers, iron and brass founders, carpenters, tinsmiths, sheet-iron workers, painters, upholsterers, etc. It may be thought, too, that while the system is practicable on a road like the Pennsylvania, where a great deal of new work is done, and standards of construction have been adopted to a greater extent than on most other roads, it may not be workable on other lines equipped with a larger variety of rolling stock and which do only repair work. As a matter of fact, there are more classes of engines on the Pennsylvania road than may be supposed. These are designated by letters and are as follows, the numbers preceding the letters indicating the number of varieties in the class: 2 A, B, B A, C, C A, 2 D, E, F, G, H, I, 2 K, L, 3 M, N, 5 O, 7 P, 2 Q, 4 R, and N. In some of these classes there are, of course, many engines which are substantially alike, and which, of course, facilitates the operation of the piece-work system. But we have here 20 classes, and besides these 25 sub-classes, all of which are repaired under the piece-work system.

Doubtless it will occur to the reader, as it did to the writer, to inquire how the system was devised and introduced and perfected. Through the courtesy of Mr. Casanave, the General Superintendent of Motive Power, and the heads of different departments and shops, who granted the privilege of investigating the subject, and of asking innumerable questions, and who answered them with a degree of patience which only Job could emulate, we have been able to obtain some idea of how the system was evolved and perfected. Although piece-work had been in vogue to a limited extent for a number of years preceding its general introduction it was not until 1880 and thereafter that it was thoroughly systematized and introduced into most of the departments. At that time Mr. Casanave was Assistant Master Mechanic in the shops, and he was largely instrumental in extending it generally in all the departments.

The method pursued was this—the work in some one department, like that of the erection of a locomotive, was selected and the separate operations or "jobs" were divided and subdivided, and a careful account was kept of the time expended on each and the cost of the time. This was repeated a sufficient number of times until it was certain that the average cost had been ascertained, and that the subdivision had been carried far enough to establish and apportion the prices for doing work. Those for piece-work were then fixed about 25 per cent. lower than the cost by day's work, and this schedule was then put in operation. It of course required a great deal of subsequent revision, which had to be done with the most conscientious care and intelligence, and with a disposition to deal fairly with both the men and the company. Prices had to be revised, and the classification changed whenever experience indicated it was required. This has been the work of years and the system still requires occasional revision. After piece-work had been adopted for some time, and the men had shown how much work they could do, further reductions in the prices were made, care being taken that by diligence the men could still earn more money than they would by day's work. It should be said here that each man is rated at a certain price per hour, at which rate he is paid when it is necessary to do time work, and an account is always kept of both the time occupied and the amount of work done, and his compensation is estimated in both ways to indicate whether the prices are excessive or too low. The following figures taken at random from a book in the boiler shop indicates the earnings of ten men for the month of June estimated in both ways. Of course they were paid piece-work prices :

Earnings estimated by day's work.	Earnings estimated by piece-work.	Earnings estimated by day's work.	Earnings estimated by piece-work.
$45.25	$53.81	$20.76	$24.72
39.82	47.41	22.26	26.50
20.76	24.72	24.78	29.50
35.40	42.14	34.40	40.96
15.12	18.00	20.52	24.44

During this period the shops were running short time, but it will be seen that the earnings of these men were considerably greates—nearly twenty per cent.—by piece-work than it would have been by day's work. Consequently piece-work is very popular with the workmen, and any proposal to abandon it and return to the system of day's work would be resisted and met with general disapproval and discontent.

Another cause of its popularity is the greater independence which it gives to the men. If any of them are suffering from malaria, lumbago or pain in the stomach, and is disinclined to work hard, it is his own affair. If disposed to condemn any pernicious political doctrines or candidates such as those advocated by the late Mr. Bryan, during working hours, a workman may do so without let or hindrance. It removes both the fact and the feeling of being driven by a taskmaster, and substitutes a sense of freedom for a feeling of servitude.

One of the results of the piece-work system, it is said, is that there are no trades-unions in Altoona, but there are many building associations and churches which are prosperous. The increased earnings of the men enables many of them to own their own houses.

One of the objections which have been made to piece work is that the men over-exert themselves and finally break down, and on this ground it has been often opposed by many of the trades-unions. This evil has appeared at times in the Altoona shops, but it is said can easily be checked. Of course, if those who are in control reduce prices too much, it will compel men to over-exertion in order to earn adequate wages, which leads to the reiteration of the statement that piece-work is practicable only where those in charge are disposed to deal fairly with those under their control, the moral of which is that geese which lay golden eggs should not be slaughtered.

Among the useful organizations at Altoona is a foremen's association, at which papers are read and discussed which relate to their various occupations and duties. At one of their meetings Mr. Thos. McKernan, General Foreman of Carpenters, read a paper in which he referred to one of the incidental disadvantages of the piece-work system which is worthy of consideration. It relates to that much-neglected individual, the apprentice. In the course of his observations Mr. McKernan said :

"That the piece-work system which has been established in the shops (though a very good thing in many ways) has a tendency to operate against the apprentice is manifest without explanation. The foreman does not always do his duty by the apprentice: the boy is not seen for days, neither inquiry is made as to how he is getting along, nor encouragement given him. This is not right, but decidedly wrong; for there is a moral obligation that every foreman assumes as foreman, to teach the apprentice a trade, and the foreman should do his best for the boy. A modest, unassuming lad frequently becomes discouraged; matters do not go right and he does not like to ask the journeymen, for he might receive the answer, 'I have no time.' The apprentice wants the sympathy and encouragement of his foreman. The foreman should talk and sympathize with him, and reach his better nature, stirring in his soul a sense of confidence, infusing in his young mind new desires, and encouraging him to have a higher aim and a nobler ambition.'

There certainly is much force in this statement. Those of us who can remember the bleak desolation of our early apprenticeship, the dreadful feeling of isolation and loneliness which comes to a boy when he is first cut loose from home and friends, will sympathize with Mr. McKernan's remarks. That the evil though, is remediable seems plain. The piece-work system demands the services of inspectors of work; these might be delegated with the additional duties of instructors of apprentices. Piece-work probably fosters, to a greater or lesser extent, the principle of every man for himself and the devil take the hindmost. What seems to be needed is a kind of supplemental good angels to look after young apprentices. It should never be forgotten that these neglected people of to-day are those who stand behind us and will certainly slip into our shoes in that very near future when we will be expected to step down and out.

As an illustration of the educational influence of piece-work it was told the writer that it often happens that men are put to work in gangs in which each man is entitled to a certain percentage of the earnings of the gang. The mathematical knowledge of some of these men is often so limited that they do not know how to calculate their proportion of the earnings. It is said that under the stimulus of this system, in a very few months, the most ignorant men learn how to calculate percentages as well as the best of them.

Another amusing incident was related. When piece-work was first introduced into the locomotive shops the W. C. accommodations were considered insufficient for the number of men who used them, and it was intended to extend their precincts. After the new system it was found that they were ample and there was room to spare.

Piece-work withal is very popular with the men, and, as one of the foremen remarked, a proposal to return to the day's work system would probably produce a strike. Wherever, as is sometimes the case, it is necessary to put men at work, temporarily, on day's work, it causes grumbling and dissatisfaction. On careful enquiry among, not only the heads of the various departments, but of the foremen of the various shops, it was found that the saving in the cost of work was estimated at from 35 to 65 per cent., and all were agreed that the amount of work turned out was doubled. The possibility of halving the cost of labor and doubling the output of work in a railroad shop is a result which certainly ought to be worthy of investigation by those who control expenditures, especially when the system may be introduced in a partial and experimental way with so little risk.

To illustrate the importance of this, it may be said that the cost of maintenance of equipment on the Pennsylvania Railroad last year was, in round figures, $9,500,000. About half of this cost, or $4,750,000, was for labor. To reduce this one-half or even a quarter is an object worth accomplishing. Besides such a saving an increase of business would be sure to demand additional shops, tools and other facilities for doing repairs before long. If the capacity of existing shops and their equipment can be doubled, as it is claimed in Altoona it has been in their shops, the extension may be postponed for a decade or longer. There is only one difficulty in the way of its introduction and successful operation in any railroad shops, that is the need of intelligent, careful, faithful and *righteous* supervision, without which it is doomed to failure. It is because it has had this in Altoona that it has succeeded to the extent it has.

It may be added, in the form of a postscript, that the information with reference to the results attained by the piece-work system in Altoona was not obtained from any one source, but was the result of independent interviews with the heads of differen departments, beginning with the General Superintendent of Motive Power, Master Mechanic, the foremen of most of the principal shops, the workmen themselves and independent observation of the writer. As remarked in the beginning of this article—either *all* these people are very much deluded with reference to what they are doing or the economy which results from paying for work done by the piece, instead of by the day or hour, is a matter of very great importance to all railroad companies and their stockholders.

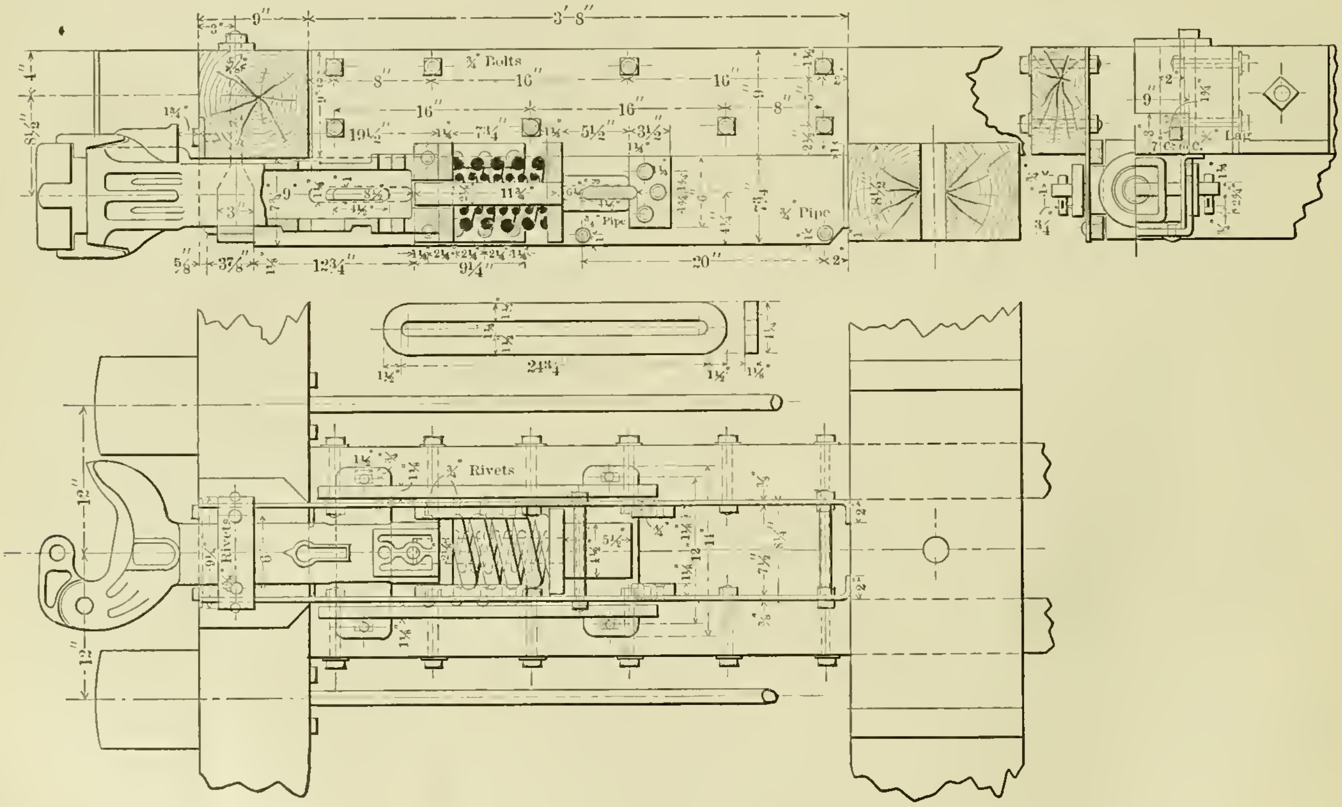
A New Freight Draft Gear.

Mr. J. G. Tomlinson, Superintendent of Motive Power of the Queen & Crescent Route at Meridian, Miss., has had in service for the past 13 months several cars equipped with a new draft gear designed by him, and from drawings ,kindly supplied by him we have made the accompanying engraving. It shows the draft gear in vertical section and in inverted plan. The first thing to be noted is that the usual draft timbers are omitted and their places taken by ⅜-inch steel plates, which are bolted on the inner faces of the center sills and extend 7⅜ inches below them. These plates are flanged against the inner face of the end sill and also against the body bolster. They extend under the end sill to its outer face and have flanges bearing against its under surface. The carry iron is in the form of a U-shaped bolt, 3 × ⅞ inches, in section with ends ⅞ inch in diameter. This fits against the outside faces of the plates and has a piece of 3 × ⅞ inch steel riveted to it between the plates, this piece keeping the plates spread and also forming a bearing strip for the coupler shank. The drawbar stops are riveted onto the inner faces of the plates, and instead of a drawbar pocket or strap there are two keys 4½ × 1 inch in section united by links outside of the plates. One key passes through the drawbar shank in much the same manner as in the American continuous draft gear, and the other key passes through the plates behind the back follower and transmits pulling strains to the latter through the socket shown. This socket has a spindle which extends through the followers and spring to hold them in place.

When the draft spring is compressed by buffing strains the force is transmitted through the followers and springs to the inner key, which is prevented from moving inward by the ends of the slot in the draft plates. The back end of the slots are reinforced by steel pieces 1⅛ inches thick riveted on them as shown. When the draft gear is subjected to pulling strains the strain is transmitted through the outer key to the links, thence through the inner key to the back follower.

It will be seen that the design does away with all vertical bolts through the center fills, and that therefore the entire draft gear can be taken down without entering the car. This is a great advantage when rep irs are to be made to loaded cars. The gear appears to be of ample strength. Mr. Tomlinson, in writing to us regarding it, says: "It may be adapted either to cars with one or two draft sills, or may be applied between sills without draft timbers, or to cars with steel or iron body framing. I have only applied it to three cars, for the reason that I wished to test it fully and beyond all question, and for a reasonable time. The test has extended for 13 months, and at the expiration of this time a careful examination shows that no repairs are necessary, and that in detail each part is in as good condition as when applied, so that I am now having the gear carefully gone over and parts redesigned to suit the various types of cars, and it is quite possible that the draft plates will be made of pressed steel, with follower guides formed integral therewith. The ease with which each individual part can be removed and replaced, the large factor of strength we are able to obtain while maintaining great simplicity of construction, together with the absence of vertical draft bolts and of bolts and nuts in all removable parts, leads me to believe that we shall obtain very satisfactory results."

The gear was first designed for dump cars having one center sill, and was afterward adapted to cars having the usual two sills. The readiness with which it can be applied to single center sills is evident. The draft gear has been patented.



A Freight Draft Cear with Steel Draft Sills.

The builders' trial trip of the *Iowa* took place last month, and the vessel averaged 16.27 knots in a strong gale during a four hours' run, the engines developing about 11,000 horse-power at 112 revolutions. The contract speed is 16 knots.

The Value of a Steam Jacket on a Locomotive.

The research committee of the Institution of Mechanical Engineers (England) have recently made a report on "The Value of the Steam Jacket," prepared by Prof. T. H. Beare and Mr. Bryan Donkin, in which is given the account of an experiment with jacketing the cylinders of a locomotive. The trials were undertaken and carried out on the Lancanshire & Yorkshire Railway, at the suggestion of Mr. John A. F. Aspinall, Chief Mechanical Engineer, who gave every assistance to the experimenters. Owing to the fact that these trials were carried out on a locomotive doing its ordinary train service, it was impossible to obtain results as complete and thorough as would have been aimed at had the experimenters been able to make the trials on a special train, the working of which could have been arranged to meet the necessities of the experiment. The trials were of short duration and the condition of the fires at the start and the finish of each had to be determined by the necessities of the traffic requirements and could not therefore be varied to suit the wishes of the experimenters. The consumption of steam was obtained with a close approach to absolute accuracy; but the same cannot be said respecting the fuel consumptian, owing to the above circumstance with regard to the condition of the fires. The results obtained are therefore not such as will enable any definite conclusions to be drawn as to the value of the steam jacket in locomotives. They are, nevertheless, interesting and valuable; and having involved considerable trouble on the part both of the experimenters during the trials and of Mr. Aspinall in the preparation of the engine for the experiment, it has been thought advisable to publish them for the use of the members. We present this condensation of the report to our readers:

"The experiment was made on a passenger locomotive, No. 1093, during its regular work of taking the 7:30 a. m. express train from Manchester to York, a distance of 76½ miles, and returning with the 3:00 p. m. express from York to Manchester. Both engine and tender are the ordinary standard pattern of this railway. The engine is a four-wheeled coupled with bogie truck, the driving wheels being 7 feet 1 inch diameter and the bogie wheels 3 feet 0½ inch. The cylinders are inside and horizontal, with their valve chests on the top. The engine wheelbase is 21 feet 6½ inches, and the total wheelbase of engine and tender 41 feet 1½ inches. The weight of engine and tender when empty is 56.287 tons, and when in working order 80.925 tons, the tender carrying 1,800 gallons of water. The boiler is of steel, 4 feet 2 inches diameter and 10 feet 7⅜ inches long; the firebox shell of steel, and the firebox of copper, 6 feet long, 4 feet 1 inch wide, and 5 feet 10 inches high. There are 220 tubes of 1⅝ inches outside diameter. The heating surface in the tubes is 1,108.73 square feet, and in the firebox 107.68 square feet; total, 1,216.41 square feet. The fire-grate area is 18.75 squate feet, the ratio of heating surface to grate area being 65 to 1. The fire-brick arch in the combustion chamber is about 2½ feet long. The height of the chimney above the fire-grate level is 10 feet. The cylinders were originally of the normal pattern, 19 inches diameter and 26 inches stroke. For this experiment they had been bored out and fitted with cast-iron liners, which reduced the internal diameter to 17½ inches, thus providing a body jacket of ⅝ inch space. The front cylinder covers were fitted with external covers, the space between the two forming a steam jacket. The back covers, however, were imperfectly jacketed by fitting over them, as close to the actual covers as possible, an annular wrought-iron ring with an inner and an outer cover, the space between the latter two forming a jacket space. The external surfaces of the end jackets were much exposed, and not well covered. A table accompanying the report shows the clearance volumes of the cylinders, and the jacketed and unjacketed internal surfaces exposed to steam in the clearances alone, and also in the clearances and cylinders at 90 per cent. of the stroke. It shows that the proportion of the clearance surface jacketed is only about a quarter of the whole, and this is mainly due to the cover jackets; of the back ends, therefore, a large part is hardly jacketed at all, in the true sense of the word.

"Four trials were made, A, B, C, D, on Sept. 18 and 19, 1894; A unjacketed and B jacketed on the 18th; C jacketed and D unjacketed on the 19th. A and C were made on the runs from Manchester to York and B and D on the return runs from York to Manchester. In each trial the weights of coal and feed-water consumed were measured, and readings of the various gages were taken, and the position of the reversing gear was noted. Indicator diagrams were obtained, and in trials C and D samples of the furnace gases were collected from the smokebox below the exhaust pipe. The coal used in the trials was from the Mitchell Main Colliery, Wombwell, near Barnsley. Samples were taken from each sack used, and were submitted to Mr. Charles J. Wilson for determining the calorific value in a calorimeter. The mean value from his tests were 14,200 thermal units per pound of dry coal, equivalent to an evaporation of 14.7 pounds of water from and at 212 degrees Fahr. The actual coal consumption per indicated horse-power per hour of steaming time in the four journeys was, respecively, 2.87, 3.07, 2.73 and 2.79 pounds.

"On the first day no attempt was made to collect the gases; and as the thermometer for taking their temperature had been fixed above the blast-pipe orifice, it was not thought worth while to note its readings. On the second day the gases were collected continuously; but the thermometer, placed in a better position, unfortunately broke almost immediately after leaving Manchester, so that the temperatures could not be ascertained. The difficult operation of collecting the gases while going at express speed was carried out by Mr. Michael Longridge. During the outward journey C much trouble was experienced, owing to the heavy chimney-blast; but in the return journey D everything worked quite satisfactorily. The mean results of the three analyses made from the sample collected on each journey are the following volumetric percentages: Trial C carbonic acid, 12.85 per cent.; oxygen, 4.15; carbonic oxide, 0.80; nitrogen, 82.20. Trial D, carbonic acid, 15.10; oxygen, 1.97; carbonic oxide, 0.85; nitrogen, 82.08 per cent.

"As arranged by Mr. Aspinall, the feed-water was measured by means of a Siemens water meter on the pipe between the tender and the injector. The overflow from the injector was caught and allowed for.

"The jackets were drained into three small tanks carried upon a temporary staging on the front of the engine; one measurement was made for the two body jackets together; another for the two front, covers, and a third for the two back covers. While standing at York on each day radiation tests were made, by measuring the quantity of steam condensed in each pair of jackets with the engine standing, all hot; these lasted 2½ hours on the first day and 1½ hours on the second. The following were the results obtained:

Condensation of Steam in Jackets, Pounds per Hour.

	While running.		While standing.	
	Sept. 1, B.	Sept. 19, C.	Sept. 18.	Sept. 19.
Two body jackets............	267	241	35.0	26.7
Two front covers............	123	103	16.0	13.7
Two back covers............	65	55	12.0	12.8

"Indicator diagrams were taken simultaneously from both ends of each cylinder. The speed in miles per hour was continuously registered by a Boyer speed recorder, kindly lent by Mr. Aspinall.

"The mean results of all the important observations may be stated thus: Comparing trials A and C, both from Manchester to York, the jacketed trial C shows a consumption of 24.49 pounds of steam per indicated horse-power per hour, against 26.70 pounds for the non-jacketed run A, or a saving of 8.3 per cent. by jacketing. Comparing trials B and D, both from York to Manchester, the figures are 24.48 pounds and 24.87 pounds respectively, or a saving of 1.5 per cent. by jacketing. Comparing the figures for coal consumption in trials A and C, the jacketed trial C shows an economy of .14 pounds per horse-power per hour, or practically 5 per cent., the increased consumption per train mile in this run being accounted for by the greater load hauled; the load was 8 per cent. greater in C than in A, the average speed being nearly the same in both runs. Comparing trials B and D, however, the jacketed trial B is distinctly less economical, the coal consumption being .28 pounds greater per horse-power per hour than in the non-jacketed trial, or 10 per cent. more; and the consumption is also greater per train mile. In these two trials, while the weight of train hauled was the same, the speed was nearly three miles an hour greater in the non-jacketed run D, with a correspondingly much increased horse-power."

In spite of the rumors as to the condition of the equipment of the B. & O. Railroad, scarcely six per cent. of the cars and locomotives are in the shops for repairs. This is a wonderfully good showing, considering that the B. & O. has 875 locomotives and 32,000 cars, and traverses a very rough country. Much of the equipment that was in bad order at the beginning of last year has been thoroughly repaired and is again in service. All but 16 of the 75 new engines, which were ordered by the Receivers last spring, have been delivered and are giving eminent satisfaction.

The company is preparing to extend its compressed air plant at the Mt. Clare shops. A new locomotive repair shop is being built, and compressed air will be very extensively used. Two 50-ton cranes have been purchased for this shop, and the power will be electricity furnished by the power-station that also furnishes the electricity for the motors and Baltimore City tunnel.

Abrasion Tests of Iron and Steel by the Cambria Iron Company.

In the laboratory of the Cambria Iron Company at Johnstown, Pa., a series of interesting abrasion tests on the material in iron and steel axles has recently been concluded, for the results of which we are indebted to Mr. L. R. Pomeroy, sales agent for the company, and Mr. C. S. Price, general manager. These tests were made by preparing from each axle several one-inch cubes, accurately gaged and carefully weighed, and subjecting these to abrasion on a steel plate. The machine employed for the purpose was the Riehle abrasion machine, already described in these columns, and, if we mistake not, the machine was designed for the Cambria Company, and the first one built was set up in their laboratory. The hard steel disk of the machine is about 12 inches in diameter, and revolves in a horizontal plane at the rate of about 60 revolutions per minute. The cubes are held in a frame and rest on the disk, the pressure being obtained by a weighted lever. A cam motion moves the cube and frame in and out over the disk. The tests were all conducted with a pressure of 50 pounds per square inch, and each cube remained in the machine during 200,000 revolutions, taking about eight days time. Two sets of tests were made on each cube. There was, of course, no abrading material between the cube and the disk. After each test was completed the cube was again weighed and the loss of material thus determined.

The axles from which specimens were tested were as follows:

Tests, Nos. 1 and 2, Wrought-iron axle from scrap pile at Cambria rolling mill.
Tests Nos. 3, 4 and 5, Wrought-iron axles from Mr. E. D. Bronner, Master Car Builder Michigan Central Railroad.
Tests Nos. 6, 7 and 8, Wrought-iron axles from Mr. George D. West, Superintendent Motive Power, N. Y., O. & W. R. R.
Tests Nos. 9, 10 and 11, Bessemer steel freight axle from Cambria Iron Company's axle plant.
Tests No. 12 to 25, Open-hearth steel passenger axles from Cambria Iron Company's axle plant.

Tests 1 and 2 represent a good muck-bar axle; tests 3, 4 and 5, a Western scrap axle, and tests 6, 7 and 8, an Eastern scrap axle. Tests 9 to 11 were made both with the steel in its natural state and treated by the Coffin process. The same is true of the tests of the open-hearth steel, Nos. 12 to 25. The Bessemer steel was low in carbon (about .10), while the open-hearth steel averaged above .40 carbon. The results of the tests and the chemical analysis are given the following table, and the loss by abrasion is also shown graphically in the accompanying diagram:

ABRARION TESTS OF CAR AXLES.

(Pressure 50 pounds per square inch, number of revolutions 200,000.)

No.	Tests of Axles.	Wt. of a cu. inch. grams.	Loss per cu. in. grams.	Loss p. c.	Analysis. C.	Si.	P.	S.	Mn
	A Wrought iron.								
1	Scrap axle..................	125.75	24.00	19.1	.09	.160	.175	.027	....
2	" "	125.80	24.20	19.2	.09	.160	.175	.027	....
3	Michigan Cen'. Ry..........	125.04	26.38	21.1	...	.138	.302	.033	....
4	" " "	126.00	24.48	19.4	...	050	.098	.052	.25
5	" " "	125 41	28.78	22.9	...	.134	.234	057	....
6	N. Y. Ont. & W. Ry.... ..	125.00	29.08	23.2	...	.164	.213	.039	.26
7	" " " "	125.00	29.05	23.2	...	.164	213	.039	.26
8	" " " "	125.44	27.65	22.0	...	.147	.237	.032	.32
	B - Steel axles.								
9	Bessemer freight—N	128.20	25.92	20.2	.12	.012	.078	.109	.52
10	" " —N.........	127.90	20.02	15.7	.10		.075	.101	.54
11	" " —T	127.95	17.01	13.3	.10	...	.075	.101	.54
12	O. H. Pass. No. 21,159—N....	128.26	20.78	16.2	.38	....	.049	....	.60
13	" " " " —T....	128.26	19.42	15.2	.38	...	.049		.60
14	" " " 21 812—N....	128.25	16.55	12.9	.38	....	...	....	.61
15	" " " " —T...	128.24	14.06	11.0	38	..	..	....	.61
16	" " " 21,795—N....	128.00	19.02	14.9	.45	....	.056	..	.51
17	" " " " —T...	128.05	12.35	9.6	.45	....	.056	...	.51
18	" " " 21,827—N....	128 01	11.22	8.8	.47	....	.043	....	.50
19	" " " " —T....	128.04	10.41	8.1	.47	..	.043	....	.50
20	" " " 21,815—N....	128.17	20.92	16.3	.45	....	.054	....	.55
2	" " " " —T....	128.20	12.86	10.0	.45	...	.054	...	.55
22	" " " 22,150—N....	128.00	11.66	9 1	.41	....	.049	....	75
23	" " " " —T ...	128.06	9.69	7.6	.41	....	.049	....	.75
24	" " " 22.153—N....	128.00	14.52	11.3	.38	....	.034	....	.68
25	" " " " —T....	128 10	13.58	10.6	.38	...	.034	....	.68

N. B.—Steel axles marked N. are in natural state after forging. "T." are "coffin treated." Heats No. 22,150 and 22,153 are basic steel; the rest acid steel.

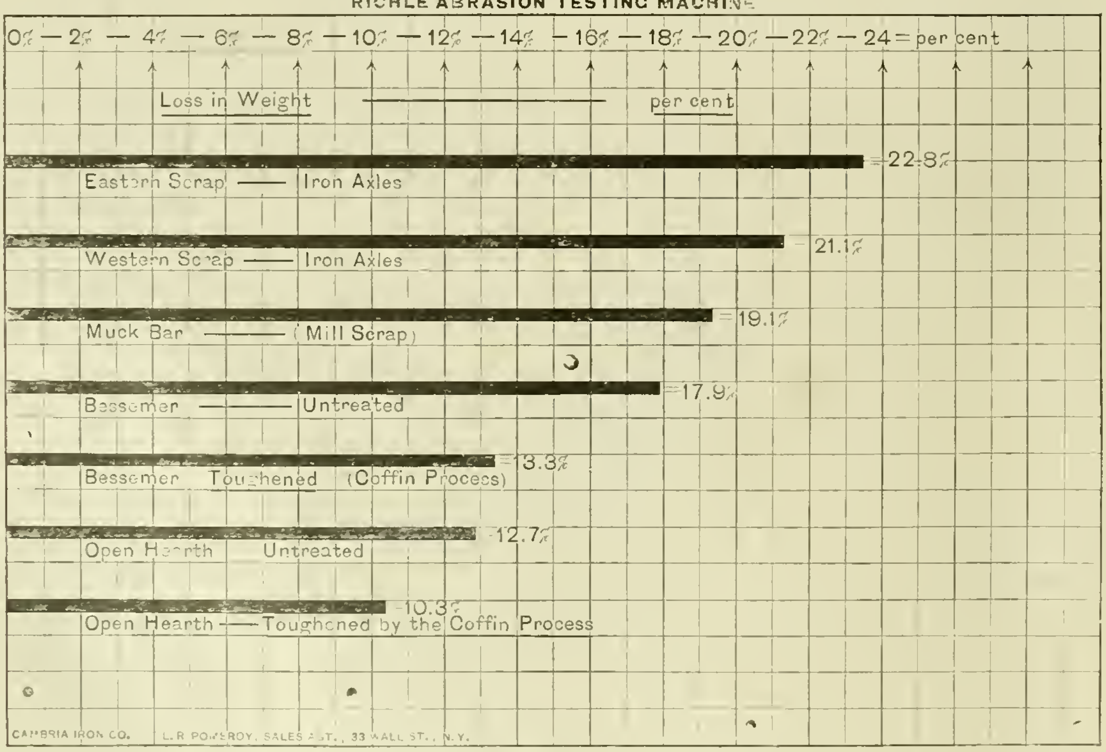
JAS. E. KRESS, Eng'r. of Tests,
C. I. Co., Sept. 14, 1896.

A comparison of the axles treated by the Coffin process with the steel axles untreated or with the iron axles is very much in favor of the Coffin process. For instance, the loss in weight of the open-hearth steel treated with the Coffin process averaged 10.3 per cent. (see diagram), while specimens from the

COMPARATIVE WEAR

LOSS IN PER CENT: 8 DAYS RUN, 200,000 REVOLUTIONS

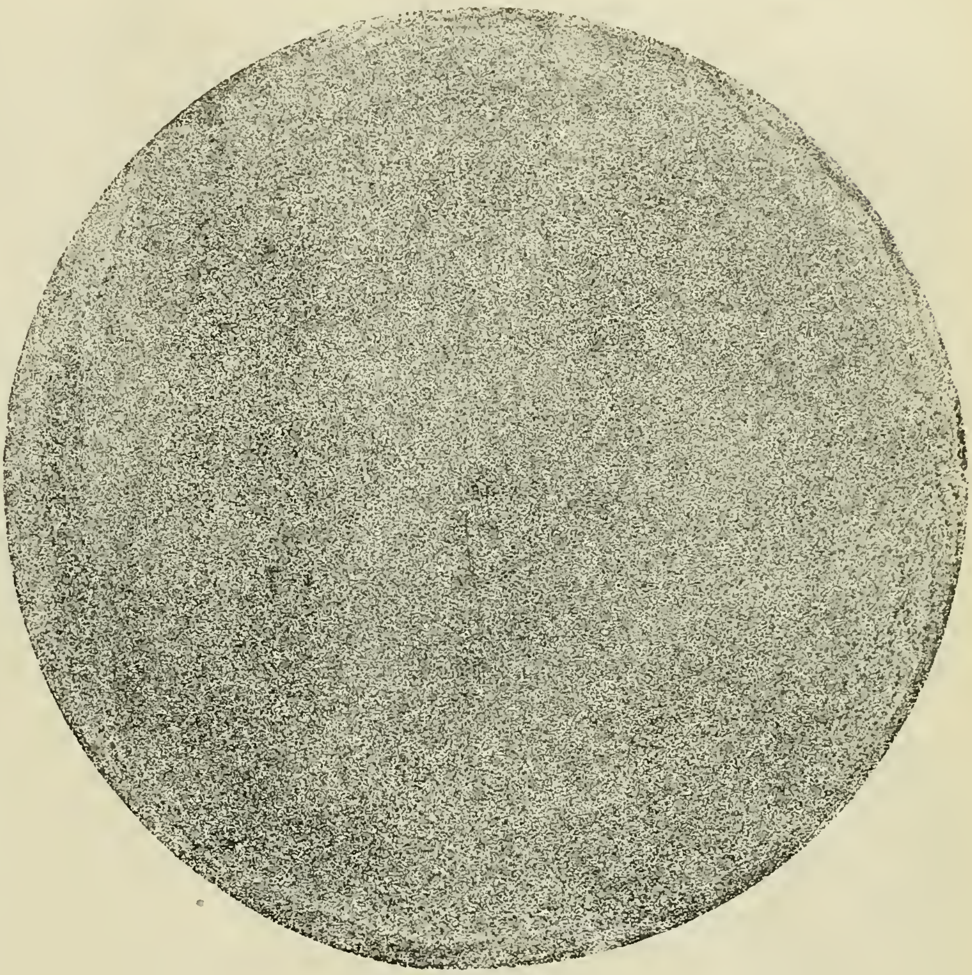
RICHLE ABRASION TESTING MACHINE



Results of Abrasion Tests of Iron, Steel Untreated, and Steel Treated by the Coffin Process.—Cambria Iron Company's Laboratory, 1896.

same axles untreated averaged 12.7 per cent., an increase of 23.3 per cent. expressed in terms of the lower figure. In the same way, if we average the three sets of iron axle tests (Eastern, Western and muck bar scrap), the loss is 21 per cent., or more than double the loss of the treated open-hearth steel.

These figures give a strong testimony to the value of the Coffin process of treating steel axles, crank-pins, etc., which is fully borne out by the results from actual practice. In an article on annealing, by H. K. Landis, which recently appeared in the *Iron Age*, some statements are made on the general subject that incidentally substantiate the claims for the Coffin process, and are of interest in this connection. Mr. Landis says:



Etching of Open-Hearth Steel Axle Treated by the Coffin Process.

After casting, forging, rolling, or drawing, steel is more or less afflicted by contending tensile and compressive stresses, often local in character but always injurious. The cause of such local strains may be incomprehensible cores in castings, local forging, either hydraulic or by hammer, rolling at too low a temperature, cold wire or tube drawing, etc.; but whether frequent cracks or breaks appear or not, the fact that these do occur occasionally is sufficient evidence that strains incident to the process do exist. It is impossible to tell what strain there is in the interior of a shaft having larger sections forged upon it. . . . Yet we find very few among the host of iron workers in this country who adopt precautions to prevent accident by providing means for removing such strains. The remedy is simple and lies in heating the piece up to temperatures to be determined by subsequent treatment, ranging from 900 to 1,600 degs. F., and allowing them co cool more or less slowly. The high temperature allows the strains to adjust the particles of steel and produces a satisfied condition in the material, the rapidity of cooling afterward determining the final state or condition of the steel. The highest temperature reached determines the extent of the effect, whether hardening or softening, while rapidity of cooling determines the quality possessed by the piece afterward. . . . If the idea is simply to remove strains in a piece, it may be heated to 1,000 degrees and cooled in the air, upon which it will be found to be tough. If greater toughness is wanted it may be cooled more rapidly, depending upon the quantity of carbon present in the steel."

Section of Wrought-Iron Axle.

The special treatment in the Coffin process is well calculated to give all the toughening effect indicated above and also to render the material dense and fine grained. We reproduce herewith the etchings of an iron axle and an open-hearth steel axle treated with the Coffin process. The photographic process is hardly adapted to the reproduction of the steel etching, as the minute, but important, changes which indicate the increasing fineness of structure near the circumfereace of the section are partly lost. Those of our readers who are sufficiently interested in the matter to write to the company can doubtless obtain impressions taken directly from the etched section.

Japanese Cruisers Contracted for in the United States.

During the past month the Japanese government placed contracts in this country for two armored cruisers, the Cramps of Philadelphia and the Union Iron Works of San Francisco each getting one to build. Each cruiser will be of about 5,700 tons displacement and will have a speed of 21 knots. The length on the water line will be about 330 feet; beam, 51 feet; draft, 20 feet, and the engines will develop 17,000 horse-power. The battery will consist of four 8-inch guns, eight 5-inch rapid-fire guns, twelve 6-pounders, four 1-pounders, and four Gatling guns. The boats must be completed in two years. The price is about $1,250,000 each. Large contracts have also been placed in Europe by the Japanese government.

Locomotive for a Six Per Cent. Grade.—Pittsburgh, Cincinnati, Chicago & St. Louis Railway.

A Locomotive Operating on a Six Per Cent. Grade—Pittsburgh, Cincinnati, Chicago & St. Louis Railway.

The engine, which we here illustrate, was especially designed for use on Madison Hill, Ind., on the Louisville Division of the Southwest system of the Pennsylvania lines. For the photograph and description of it we are indebted to Mr. S. P. Bush, Superintendent of Motive Power, who was called upon to provide for the unusual conditions existing at that point. The peculiar conditions of the service at that place necessitated many departures from customary locomotive construction, and the proportions of the engine are consequently somewhat different from ordinary practice, and, in cylinder volume, it does not entirely conform to the rules recommended by the Master Mechanics' Association.

The grade upon which this engine has to wear away its existence, climbing and pushing with all the power its weight permits of, and then gliding down again without steam, is one of the steepest in the world upon which a regular passenger and freight service is maintained with the sole aid of adhesive power. The length of the grade is 7,012 feet and the total elevation is 413 feet, making a ratio of 311 feet per mile, or approximately a 5.9 per cent. rise.

When ascending this grade the cars, as a precaution in case of broken couplings, are pushed before the engine, and when descending the engine backs down preceding the cars. It is to be understood that the regular road engines are disconnected from their trains at the top of the grade, and left there waiting for the next train brought up by the hill engine.

In order to prevent the trains from gaining too much headway during the descent the engine is equipped with an interesting arrangement for regulating the speed. This device is based on the principle of the Chatelier brake, and is in some respects similar to that used on several of the Western mountain roads. It consists of connecting the valve chests with a 1½-inch pipe from which a 2-inch connection runs back to a point below the cab floor at the engineer's side where it terminates in a muffler. When descending the hill the link motion of the engine is reversed so that the cylinders during a portion of the stroke will force air up into the valve chests and from there through this pipe to the muffler, where it escapes into the atmosphere. By means of a regulating valve below the cab floor the escape of the air can be checked so as to obtain the desirable speed for the pistons and consequently for the engine. By closing the valve entirely the engine can be stopped during the descent.

In order to prevent the pistons sucking in air from the smoke-box with accompanying cinders and grit, a steam jet is directed upward through the exhaust pipe from an opening in the hollow wall dividing the two exhaust passages. Fresh, clean air is admitted into the cylinders from a connection at the exhaust pipe base which leads to the outside of the smoke-box, and is shown over the valve chest in the illustration. This connection can be opened or closed by means of a valve operated from the cab, and it is apparent that it must be opened only when descending the grade. In order to lubricate the cylinders a small jet of hot water is let into each exhaust passage.

Besides this regulating device the engine is equipped with the American driver brake, and in addition a powerful screw hand brake, which alone will hold the engine and train on the grade.

As before stated, the service for which the engine was designed necessitated a departure from the customary proportions of locomotives. A road engine has to exercise its entire hauling capacity only when starting a train and getting up speed, but during the majority of the time only a fraction of the tractive power is needed. The total adhesive weight on the drivers is never utilized when the train is running at its regular speed with the lever hooked up toward the middle. It is then that the economy of expansion comes in. The exertion of the full adhesive power is not the exception but the normal condition of work on the Madison Hill. To use steam expansively under these conditions would be impossible, unless the cylinders were of much greater proportions, with regard to the adhesive weight, than on the ordinary road engine. The total weight of the new engine is 140,000 pounds, all adhesive weight, but the mean weight during the ascent is about 130,000 pounds, based on consuming two-thirds of the water in the side tanks. According to ordinary practice this weight would require a cylinder of about 22 inches by 24¾ inches. The additional 3¼ inches of the stroke which this engine has is a clear gain in the expansion of the steam, over and above that which may be produced when the engine does not exert its full adhesive power up to the slipping point. In other words, the cylinders were made as large as it was practical to make them, and the economy of this is shown by the fact that ordinarily the engine is able to make three round trips up and down the hill without refilling its coal bunker, which holds only a ton and a half of coal.

The engine was placed in service the first of the year, and has been giving entire satisfaction ever since. No official test of its hauling capacity has yet been made, although it is the intention to do so in the near future in order to obtain reliable data for comparison and future use. It can be said now, however, that the engine has fully met the expectations of the officials, and its performance during the ascent, as well as the descent, is entirely satisfactory.

Quite a number of interesting details had to be considered in the design of the engine. In order to keep the front end of the top row of flues under water on the grade without filling the boiler so full as to cause the engine to throw water the back end of the boiler is set considerably higher than the front end. The throttle valve is of the ordinary balance type, but it has no play on its stem, the object being to avoid the clattering of the valve upon its seat in case the compression in the steam chest should exceed the boiler pressure during the descent. To protect the steam chests a relief valve has been placed on each, which is set just beyond boiler pressure. In arranging the driving springs for the engine it was calculated that the front springs would receive the greatest load and they were designed accordingly. When the engine is on the grade, however, its center of gravity is shifted backwards, and in consequence the rear springs receive the greatest load, which caused some little inconvenience at first.

Instead of metallic piston-rod packing, asbestos cord is used, as the metallic packing would be apt to be damaged when the engine is drifting down the hill without steam. The engine is equipped with a pneumatic bell ringer, pneumatic sand valves, steam heat for passenger trains, and all modern improvements.

The leading dimensions are as follows:

NO. 631—TANK LOCOMOTIVE, NON-COMPOUND, STANDARD GAGE.

Fuel	Bituminous coal
Driving wheels, number	8
" " diameter	50 inches
Driving axle journals	8 inches by 8½ inches
Wheel base (all rigid)	15 feet 3 inches
Cylinders, diameter	22 inches
" stroke	28 inches
" spread of centers	7 feet 4 inches
Crosshead	Solid cast steel
Main rod, length between centers	9 feet 10⅝ inches
Valve gear	Stephenson link motion, Richardson balance valve
" " steam ports	1¼ inches by 18 inches
" " exhaust ports	2¾ inches by 18 inches
" " outside lap	1 inch
" " inside lap	3/16 inch
" " valve travel	60 inches
" " lead	1/16 inch
Boiler: Inside diameter of barrel	5 feet
" Thickness of sheet	7/16 inches
" Height from rail to center	7 feet 6 inches
" Steam pressure	150 pounds
Firebox:	Belpaire
" Length inside	7 feet 9⅛ inches
" Width " at bottom	3 feet 6 inches
" Depth	4 feet 9½ inches
" Grate area	27 square feet
Tubes: Number	219
" Diameter outside	2 inches
" Length between tube sheets	13 feet 4⅝ inches
" Total area of tube sections	3.65 square feet
Heating surface, firebox	142.86 square feet
" " tubes, exterior	1,528.89 square feet
" " total	1,671 75 square feet
" " ratio to grate area	61.91 to 1
Exhaust nozzle, single, diameter	5 inches
Smoke stack, minimum diameter	18 inches
" " height from rail	15 feet
Capacity of tanks	2,000 gallons
Capacity of coal space	3,000 pounds
Tractive power, per pound, effective pressure on piston	271 pounds
" " total with 80 per cent. of boiler pressure	32,520 pounds
" " total adhesive, at 25 p. c. weight on drivers	35,000 pounds
Weight in working order	140,000 pounds

More Engineer Officers Required in the Navy.

The necessity of increasing the number of engineer officers in the navy is touched upon in the annual report of Commodore Melville, Engineer-in-Chief of the Bureau of Steam Engineering. He warns Congress, and incidentally the country at large, of the futility of building powerful warships without providing the necessary number of skilled officers to operate and maintain them. He says:

"I feel that it is only necessary to direct your attention to the number of engineer officers who have been retired during the past year for physical incapacity, and to the steadily increasing number of such officers on the retired list, to demonstrate that the physical strain to which the officers of the engineer corps are subjected is too great. In former annual reports I have given what I believe to be abundant reasons for an increase in the number of officers of the corps. As time goes on, and the number of ships and their power increase, the necessity for such an increase is intensified, and I feel that I would not be doing my duty if I did not again briefly refer to the matter.

"The personal element is one which must enter largely into the result of any naval engagement, and if we had the most powerful and the swiftest navy afloat it would be valueless to us in time of war if we had not a sufficient number of trained men to see that the machinery of this fleet is in condition for action and to keep it going in action. The guns will be powerless without the machinery, and, other things being equal, that fleet will give the best account of itself which has the best equipment of trained men in the engine-room, as well as at the guns. To sacrifice the one is merely inviting disaster to the whole, and no amount of skill on deck can compensate for the lack of it below."

It is to be hoped that Congress will take steps to correct this present weakness of the navy at its next session. The personal element is not made unduly prominent in the above statement, as any one who reads the past history of our own navy will readily appreciate. If the policy of this country is going to be the maintenance of a navy of only moderate size it is all the more important that every element tending to make it superbly efficient should receive attention. The most important naval matter now calling for consideration is the status of the engineer officers and the much-needed increase in their numbers.

The June Conventions for 1897.

The Master Car Builders' and Master Mechanics' associations will hold their annual conventions in 1897 at Old Point Comfort. The Hotel Chamberlin has been selected as headquarters, and the hotel rates will be the same as usual, namely:

	Without bath.	With bath.
Single room, 1 person	$3 per day	$4 per day
Double room, 1 person	4 "	5 "
Double room, 2 persons	3 "	4 "

The Hygeia Hotel, across the street from the Chamberlin, will make the same rates to members and their friends. At the Chamberlin rooms will be assigned only to members of the associations until March 1, after which application from others will be received. The Chamberlin is a new hotel of large dimensions and with excellent accommodations, and with the two hotels open there should be ample room for the great numbers who now attend these conventions annually.

The Baltimore & Ohio Tunnel Plant.

Within the next six weeks the three General Electric motors that have been used for the past year in hauling freight trains through the Baltimore City tunnel of the Baltimore & Ohio Railroad, will begin to handle the passenger trains in the same manner. The overhead trolley is being extended three-quarters of a mile north of the Mt. Royal station and about 1,500 feet at the south end of the tunnel. The motors are giving splendid satisfaction. The maximum load that has been hauled so far consisted of 41 loaded freight cars and two heavy locomotives. By the extension of the trolley line north and south of the tunnel entrances the helping engine will no longer be needed.

The new Mt. Royal station, at the northern end of the tunnel, is almost completed and it is a handsome and well-appointed passenger station. Attention has not only been paid to the architectural beauty, but the landscape gardener has given his best efforts toward beautifying the surrounding grounds. It is probable that the company will reconstruct its Camden station, at the other end of the tunnel, so that passenger trains will not have to back in and out, as has to be done at present. It is contemplated to erect new passenger sheds and necessary buildings near the mouth of the tunnel, by which the movements of trains between Washington and New York will be greatly accelerated.

The electric power plant is now being used not only to furnish the power for the tunnel motors, but to run 180 street cars of the Baltimore Traction Company, to light the Camden station and yards, the Baltimore City tunnel, the Locust Point freight-houses, warehouses and yards, Mt. Clare shops and the new Mt. Royal passenger station.

The four large engines generating electricity for power purposes are to be supplemented by a fifth engine. The foundations for it were laid long ago, and the installation of the engine is now in progress. A 250 horse-power engine is also being added to the equipment devoted to lighting purposes.

A use for compressed air new to most of our readers is found in this plant. This is its utilization for forcing oil to the cups that lubricate the machinery. Tanks of oil are kept under about 60 pounds' pressure, and from these the oil is piped to the various bearings of the engines and dynamos. At the cups the pressure is about six pounds. The cups are always full of oil, and the rate of flow is adjusted in the usual way. The cylinder lubricators are not included in this compressed-air system, but cylinder oil is delivered under air pressure to a convenient faucet in the engine-room, where it is drawn off into cans for filling the lubricators. Westinghouse pumps maintain the air pressure.

The system installed by the movement of trains through the tunnel is, of course, very irregular at present, giving long intervals when no power is used. To meet this condition a low, smouldering fire is maintained under the boilers, and the machinery is kept at a standstill except when trains are being moved. The approach of each train is telegraphed to the power house, when the blowers are speeded up and steam is soon generated at a rapid rate and the engines and dynamos are started up to supply current for the moving of the train by the electric locomotive.

Electric Traction Under Steam-Railway Conditions.*

BY DR. CHARLES E. EMERY.

In the light of recent achievements, it can be assumed at the outset that electric traction under steam-railway conditions is feasible. The only question is whether it will pay. The present applications only prove the former proposition, but do not touch the latter.

The greatest practical efficiency of an electric system of the kind proposed between the engines at the central station and the rails would probably be 60 per cent. This, on account of a second transmission to sub-stations and the necessity of using rheostatic regulation to some extent, would probably be reduced to 50 per cent., so that twice as many horse-power would need to be generated at the central station as at the track with the present steam locomotives. Each horse-power in the central station will be developed for two pounds of cheap coal or four pounds per net horse-power delivered, whereas the steam passenger locomotive will on the average require six pounds, based on net tractive force and allowing for the various wastes. The saving in coal due to electric passenger traction will, therefore, be one-third. Coal is procured cheaply by the railroads, but probably an inferior quality, costing 50 cents per ton, or, say, 25 per cent. less than that used on locomotives, could be employed in the electric stations, so that, for trains of like weight the saving in cost of coal for passenger service would be $\frac{3}{4} \times \frac{2}{3} = \frac{1}{2}$. For freight engines we calculate the saving in cost for fuel will be about 55 per cent., and for switching engines about 66⅔ per cent. On railroads running through the coal regions the total cost is about 9 per cent. of the total operating expenses. A saving of one-half in the cost of the coal, then, corresponds to a saving of 5 per cent. of operating expenses. For reasons that will be stated later, it is believed that, for general railroad work, independent electric locomotives will be required, and that these will necessarily be as heavy as present steam locomotives, on which basis the only saving in weight will be that of the tender, which we have assumed as 10 per cent. of the total weight of the train for passenger engines, 3.3 per cent. for freight engines, and 5 per cent. for switching engines. The total load to be hauled will therefore be decreased by these several percentages, and the cost of coal reduced thereby to 45 per cent. of that required by the present locomotives for passenger trains; 43½ per cent. for freight trains and 32 per cent. for switching trains. Applying these percentages for the relative amounts of coal used for these different purposes on a prominent railroad, the average saving in fuel becomes 58.9 per cent., or 5.89 per cent. of operating expenses. The cost of water is taken at two-thirds of 1 per cent. on the same basis which increases the saving to 6.56 per cent.

Considerable saving has been claimed on other grounds. First, in relative repairs of electric motors compared with locomotives. Repairs will be less on the motors, of course, but they are not inconsiderable, and when we consider that the transmission line, trolley line and trolleys must be kept in repair as well as the motors, it cannot be far in error to assume that the question of repairs will be about balanced, independent of central station apparatus otherwise provided for.

It has been claimed that labor will be saved, because the second man on an electric locomotive is required simply to provide for sickness or accident of the driver, and can well be the baggageman of a passenger train or the conductor of a freight train. Something of this kind may be worked out on an unimportant country road, but it would be impracticable on a large business scale.

It is also claimed that there will be a saving in the weight and cost of electric locomotives, particularly when applied under a car, but this system is of limited application. Heavy locomotives on trunk lines must have the same weight for electric as for steam traction, independent of the tender. Large savings in repairs to tracks and bridges are also claimed on account of the smoothness with which electric locomotives, having no reciprocating parts, would operate. The same weights must be run over the same rails at the same speed, and at least a great part of the wear and tear would be due to inequalities of the track surface, which would influence both systems alike. The present locomotives are so designed that, while the wheel loads on the drivers are heavy, the masses which strike blows are comparatively light; that is, they have simple wheels and axles, spring-connected to the frames. This is a very difficult thing to accomplish with an electric locomotive without using exactly the same construction. Each pair of wheels and attached motor acts as an enormous trip-hammer on the rails and roadbed the moment the former gets the least out of alignment. A connection to driving axles through gearing reduces the blows very materially, but introduces at high speed another difficulty. The vertical movements of the main axle would necessarily cause a change in the angular velocity of the armature during the time of such movement, which, for jars occurring in the fraction of a second would bring a heavy strain on the gearing and vary the speed of the armature momentarily. The variations in current due to such variation may also give a longitudinal pulsation to the train. The matter is not helped at all by mounting the motors on hollow axles concentric with the driving axles, so that the motors may be spring-supported from the axles, for in such case the connection of the motor to the axles must be through links the equivalent of a universal joint, which produce variations in velocity, when the axles are out of center with the armature, similar to those where gearing is employed.

For reasons above given, it will be necessary to mount electric motors for fast locomotives away from the centers of the axles and connect through side rods, as in the present locomotives. There is another important reason for this. In order to obtain speed, the motors must be wound for it so that the counter-electro-motive force will be produced by velocity rather than the number of turns, and, in starting, the motors are necessarily connected in series so as to reduce the starting current. For motors adapted to very high speeds, it will be necessary to put pairs in series even to surmount heavy grades, to act as pushers in case of accident, or in removing snow, etc. The counter-electro-motive-force is therefore divided between several motors, but not necessarily in equal degree. If, with motors connected to separate axles, one for any reason slips its wheels, it will monopolize the larger portion of the electromotive force and cut down the current on all the motors in series, so that full power cannot be obtained. Working the motors in parallel with an enormous rheostat would be wasteful, and, in some cases, impracticable. It is, therefore, important for two reasons to connect driving wheels operated by separate motors by means of side rods.

Again, it is essential, that, on the road, speed be regulated by better means than a rheostat. A series motor varies its speed with the load and so cannot run without rheostatic regulation at a given speed if for any reason the number of cars in the train or the track resistance varies. It will, therefore, be necessary to return to commuted series field coils or equivalents, and it will be perhaps desirable to have a shunt winding which can be used to give still closer regulation. In fact, shunt motors are being introduced abroad for traction purposes. The use of these devices will increase the weight of the motors compared with simple series-wound motors. These considerations make more room desirable for the motors than can be provided in the trucks of an ordinary car.

For these several reasons it is predicted that the high-speed electric locomotive of the future will, like the steam locomotive, be a structure independent of the train, that the motors will be hung on the frame independent of the driving wheels, and the same as

* From a paper presented at the meeting of the American Institute of Electrical Engineers, New York, Oct. 21, and Chicago, Oct. 28, 1896.

well as the driving wheels connected by side rods. To obtain proper room under such conditions larger driving wheels will be employed than the wheels of an ordinary car. This will so extend the wheel base that it will not be safe to run at high speeds without the leading truck, the same as on an ordinary locomotive, and, in fact, the electric locomotive will in all its general features be a steam locomotive without the boiler, with motors substituted for the steam cylinders. In this way and probably in no other can the flexibility of the present steam locomotive be obtained. Again, it is desirable that the whole locomotive be a unit, on a strong frame, calculated to resist the shocks due to collisions and accidents, and it is doubtful if locomotive drivers will be found who will be willing to risk their lives on any other kind of a structure.

To realize the flexibility of the ordinary locomotive one has but to go on the line of one of the roads which has not yet adopted the heaviest type of rail, but yet runs express trains at 45 miles per hour, grasp a convenient post close to the line and a little around a curve, if possible, where one can take the wind of the train, and watch its approach. In many cases the locomotive sways nearly a foot from the perpendicular, first one way and then the other. At a bad joint the plunge is so rapid that the effect can be described as terrific, as one cannot but think of the consequences if such a mass should leave the rails. The locomotive, however, follows the inequalities as readily as would a farm wagon. Electrical engineers may insist upon a more rigid and better track, but this will require additional expense and will not entirely overcome the difficulty. The electric locomotive must be constructed so that it will do the work of the present locomotive in the same way, and the feature of flexibility cannot be sacrificed.

A modern heavy locomotive costs about $10,000, which is at the rate of $10 to $12 per horse-power, on about the same basis as electric motors would be rated. It needs little argument to show that an electric locomotive, to take its place under conditions stated, would cost fully as much. Moreover, if like care is to be taken of electric locomotives as of those for steam, the same number must be employed of like capacity for like work.

An approximate calculation of the cost of electrically equipping and operating a trunk line has been based on information in regard to the operating expenses of different railroads, given in the series of articles by Mr. Baxter, in *The Electrical Engineer* early this year. We have adopted his facts, and for convenience have used some of his methods, but have been obliged to entirely disagree with his conclusions. For instance, we calculate that the cost of the steam and electric generating plants will be about three times as much as he states, the transmission plant and sub-stations about twice as much, and the operating expenses about 5½ times as much as he provides for. Necessarily the conclusions are diametrically opposite.

The calculations are based on the operating expenses of a railway system comprising nearly 2,700 miles of road, and employing 1,800 locomotives. By calculations based on the train miles, checked by the reported coal burned, and the probable number of engines in use, we estimate it will require 280,000 horse-power in the stations, on the basis of 50 per cent. efficiency from stationary engine pistons to track, and if 60 per cent. can be obtained by commutated fields, or other means herein discussed, the difference simply provides for an expected increase of travel. From the probable average power and the actual reported operating expenses corresponding thereto, we proceed as follows : For facility of calculation and to obtain an underestimate, rather than one too large, the power required for the switching engines is distributed among the regular trains on the road. It is also assumed that the average number of trains is continued the entire length of the road, instead of using a much greater number than the average for suburban travel. These methods cause an underestimate of the cost of the electric transmission, but enable the cost of operation to be accurately worked up from the averages. The latter is the more important point, as the other merely involves comparatively small questions of difference in the amount of interest.

By this generalization the trains will be assumed as separated about 7½ miles, independent of direction, over the whole length of the road for every hour in the year. On this basis there will be required on the average 106 station horse-power per mile of road, independent of direction of trains, but to provide for concentrations which will inevitably occur, the generating plants and transmission lines have been worked out on the basis of 150 horse-power per mile. The assumed number of trains will require on the average about 400 horse-power each at track, or 800 at station. To obtain the economy due to fairly large stations they are assumed to be separated 45 miles from each other, and at two intermediate points transformers and rotary converters (transformers) located, by which means the feeders are supplied every 15 miles. On the above basis it is assumed that 6,750 horse-power is installed at each steam station, and 2,250 horse-power at each sub-station.

To avoid overestimates the cost per horse-power of steam and electric plant in main stations has been assumed as only $80 per horse-power with $20,000 for buildings, and for the whole apparatus in the sub-stations there has been allowed only $10 per horse-power and $10,200 for buildings and the copper in the high-tension lines. The low-tension copper has been worked out on the basis that half-way between the main and sub-station two trains may meet, each requiring 1,000 horse power, and that a uniform section of copper sufficient to carry 7½ miles, the current required for half of this power, at an original tension of 700 volts and a drop of 20 per cent., would be ample for the whole length of the low-tension lines. On this basis the cost of copper at this basis the cost for copper at 13 cents per pound for the outgoing low-tension conductors will be $12,386 per mile. It is assumed that provision for supporting the outgoing conductors and the bonds in main track for return current will cost $5,000 per mile.

On the basis of these prices, without considering incidentals, the total cost of the electrical generating and transmission plant foots up $31,057 per mile, the annual interest on which, at 5 per cent., is $1,553 per mile. If the services of the 1,800 steam locomotives can be furnished by 1,500 new electric locomotives at $10,000 each, the same will cost $5,556 per mile, requiring $278 annual interest per mile, making the total interest on steam and electrical plants, including locomotives, $1,831 per mile. The operating expenses of the station, considered as a steam station only, from Emery's tables, reduced to 24 hours and 365 days, modifying cost of plant and eliminating coal and interest, is found to be $25.84 per average horse-power per year. The time of 12 extra men for care of electric apparatus in the main and two sub-stations amounts to $2.75 per horse-power per year, which makes the total operating expenses of the generating, transmission and locomotive plants, exclusive of coal and interest, $28.59 per average main station horse-power per year, or $3,031 per mile, or, with interest added, viz., $1,831, as above, a total of $4,862 per mile. The operating expenses of the station thus calculated include an allowance for repairs, insurance, taxes and renewals.

It should be recollected that the cost of coal has been already provided for in the percentage of saving first developed, and that the train expenses are assumed to be the same as for steam locomotives. The operating expenses of the road using steam amounted to $15,187 per mile. Of this, as previously stated, 6.56 per cent. will be saved by the use of electricity, corresponding to $996 per mile. This subtracted from $4,862 per mile (given as the cost of operating expenses of the generating stations, etc., with interest added), leaves $3,866 per mile per year as the additional expense which will be entailed by the application of electricity as a substitute for steam ; so, on the basis that the operating expenses are 50 per cent. of the gross receipts, such gross receipts must be increased 12¾ per cent. by the introduction of electricity over the whole length of the line, in order to enable the road to pay the same dividends as before.

It may be considered that the results will be changed materially by the use of high-tension transmission throughout. If tri-phase currents at a tension of 10,000 volts were received by each electrical locomotive, the tension reduced by transformers carried by the locomotive, and current employed to operate induction motors directly, or to operate direct current motors through rotary converters also carried by the locomotives, the saving independent of extra transformers and converters would amount to $9,714 per mile, corresponding to $486 interest per mile, and reduce the total increased operating expenses to $3,380 per mile, which would require that the gross receipts be increased 10.2 per cent. in order to pay the same dividend as before, instead of 12¾ per cent., for combined high and low tension transmission. The saving in dollars is quite large, but the total costs are so enormous that the saving makes but a small difference in percentage. It will similarly be seen that differences in kind of apparatus employed will have very little difference on the general results, though the savings are important in themselves.

It must be recollected that these results are based on providing electric traction for the whole length of a trunk line. It can hardly be expected that the gross receipts for the whole line will be increased, say one-eighth, by such an application. If, however, the application be made within the radius of suburban traffic such an increase is not only probable, but it may be expected that the cost of operation per passenger mile will be reduced in greater proportion than stated, so that the application of electric traction will pay from the outset. These considerations will apply to longer distances on railroads like the New York, New Haven & Hartford, where the passenger business furnishes the larger proportion of the income.

Again, it is possible to accomplish with the electric locomotive results that are impossible with the steam locomotive. The power for the former being generated originally in stationary boilers, or in some localities derived from waterfalls, is not limited, and the power of the motor can be increased indefinitely, so that in particular locations a demand either for greater power to obtain more speed, or a greater or more continued tractive force than is now possible with a steam locomotive, can be met by electricity without difficulty.

On the whole, therefore, although the application to the whole length of trunk lines does not seem practicable under present conditions, there is no doubt but that the industry will grow in the future as certainly as in the past.

Communications.

Water-Spray Firing.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I notice that the discussion of Professor Goss' experiments has, among other new (?) things, brought out the fact that a small amount of water introduced into the flame of coal fire in a spray improves the fire, *i. e.*, increases its heat. The daily practice of every country blacksmith for the last 100 years has proved it. The experience of every active member of any fire department is to the effect that the first few streams thrown on a blaze acts almost like so much powder, especially if in a frame building or a pile of lumber.

R. ANGST,
Chief Engineer, Duluth & Iron Range Railroad.

[The point which was especially brought out in the discussion referred to was not that the admixture of a small amount of moisture with a fire was new, but that it was beneficial in a steam boiler, a fact which is certainly not well established or generally known. If our correspondent knows of the actual use of water-spray in firing a boiler of any kind, it would be very interesting to know the particulars.—EDITOR AMERICAN ENGINEER.]

Fire-Resisting Qualities of Graphite Paint.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In your issue of November we note an article on "Graphite Paint for Metal Work." There are so many good qualities about graphite paint, when properly made, that we think it extremely unwise to exaggerate such qualities. In the face of the testimony which you mention, there would seem to be no contradiction possible to the statement that " a fire in the neighboring flour sheds played upon ironwork, painted with graphite paint, for two and a half hours without blistering the paint," and yet we cannot help but think that there is a mistake somewhere in this statement.

Over 25 years ago, the Joseph Dixon Crucible Company, Jersey City, N. J., had its attention called to the virtues of graphite paint, by its mine superintendent, who had for the past 10 to 15 years been making graphite paint and using it on roofs of various kinds in the neighborhood of Ticonderoga, N. Y. It was shown conclusively that roofs properly painted did not require repainting in 10 to 15 years. Furthermore, that as graphite was about three times the bulk of lead, and about twice the bulk of mineral paints, it had correspondingly that much more covering power, and that for economy, as well as for durability, it seemed to be the proper paint to use for protecting roofs, whether of metal, wood or canvas. Believing that graphite paint would be a fitting addition to the company's graphite products, the Dixon Company began the manufacture of graphite paint, uniting with it a certain proportion of silica, and putting it on the market under the title of silica-graphite paint.

During the years since the company began the manufacture of this paint, tests of almost every conceivable character have been made with the paint, but we must confess that we have never yet made a paint that would successfully stand the fire test mentioned above.

There is no question of the fire-proof qualities of graphite, but there must necessarilly be some binder to hold the graphite to the painted surfaces. Various oils have been tried, and various other vehicles, and although we have called in the services of many chemists, and even the expert of the National Oil Company, we have yet to find any organic substance in the way of oil or a vehicle that will successfully withstand high degrees of heat, and as we have above said, there are so many good qualities in a graphite paint properly made, that we regret to see any statements made that seem to be exaggerated and which, if tested by an interested party, may cause more or less prejudice against a paint that is destined to be hereafter recognized as a best preservative and protective paint for all kinds of work, exposed to the various agencies so destructive to paint.

Permit us also to say that, during the past two to three years, various graphite paints have made their appearance on the market that lack the essential qualities of perfect graphite paint. There are graphite paints that are made of ordinary plumbago foundry facings; there are even graphite paints that are made of simply mineral paint, colored with lamp black. To such an extent are these paints now made, that it will be well for the public to know just what the article is before orders are placed.

JOS. DIXON CRUCIBLE COMPANY.

NEW JERSEY, Nov, 23, 1896.

The Needs of Our Navy.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

Since the launching of the *Indiana*, the first of our 10,300-ton first-class battleships, in February, 1893 (this ship was commissioned during the last of November, 1895), the British Admiralty has designed, constructed, tried and placed in commission the two first battleships of the *Majestic* class, of 14,900 tons displacement. And not only this, but the 12-inch guns forming their main battery are of entirely new design and exeeedingly powerful; in fact, they are more than equal to the 13-inch U. S. Naval guns in power, and weigh 16 tons less. The 6-inch and 3-inch (12-pounder) quick-firers, also, and the mounts for all the guns on board are of new design, and all the guns from the largest to the smallest, use smokeless powder, a satisfactory variety of which, called "cordite," from its form, having been secured long ago.

By the time that our two new battleships of the *Kearsarge* class are completed, even though it takes only three years, the British Navy will have been reinforced by all the ships of the *Majestic* class; one or two type ships of a new class of battleship will have been pushed forward to completion and more will be under construction, and three or four dozen cruisers, many of them of high speed and power, fully armed, will have been added to their gigantic navy.

France has under construction some thirty-four ships, and Russia is not so very far behind France, for, taking into consideration the new battleships just commenced, she has almost double the number of armored ships building. Italy, in spite of her poverty, has eight armor-clads building and they are being completed more rapidly than any of her previously constructed ships, and Germany has four and Spain five armored ships building.

During the time that the new United States ships are under construction it would seem probable that Great Britain can safely be counted on to complete 12 ships of the battleship class, France five or six and a couple of armored cruisers, and Russia twice as many battleships and armored cruisers as France, as she has a large number of armor-clads completing afloat, besides those on the stocks.

Following the example set by Great Britain in working nights by the use of the electric light, in completing the *Magnificent*, she is pushing the completion of some of her ships by night as well as by day, and it is hoped that the new ships recently laid down will be completed in two years by following this system.

Naval construction seems to be the fad of the age as far as nations are concerned, and the Argentine Republic, with its 4,000,000 inhabitants, has to-day laid up at its naval station on the Tigne River more first-class torpedo boats than the United States will possess when all those building and authorized are completed, and she is having built in Great Britain six "destroyers" of the same type as the Russian *Sokol*, an improvement on the British *Havock* class of boats, both of which you have described.

When Ex-Secretary Tracey, some years ago, told us what position the United States Navy would occupy among the navies of the world, when all the ships authorized were completed, it is evident that he did not take into consideration the increase that would take place in all the other great navies, and the increased rapidity of construction the world over. Nothing is plainer to a person who reviews the present condition of the United States Navy, and compares it with the other navies, than that it is entirely inadequate to the present needs of the country.

If we are ever to have a navy at all in keeping with our probable needs, and are not going to try and construct one in an emergency, at great cost, and then probably make a failure of it, it is surely time that we set about its construction in sober earnest, following some well-devised plan formed with a definite object in view.

And now, what of all our experiments with wire-wound guns, of which we heard so much at one time? The new Woolwich (British government) 12-inch guns are wire-wound and steel-jacketed The new Elswick (Armstrong) 12-inch, 8-inch and 6-inch guns are wire-wound and steel-jacketed. British, Japanese, Italian, Argentine and Chilian ships are being armed with these guns.

The new Woolwich 12-inch guns give a muzzle energy of 33,940 foot-tons, and a perforation of 38.5 inches in wrought iron. Our 13-inch guns, with their 16 tons more weight, have 33,627 foot-tons of muzzle energy, and perforate 34.6 inches. The Elswick 12-inch guns for Japan are even more powerful, as they are five calibers longer. Both these guns, it is said, can easily be loaded and fired twice while our 13-inch guns are being loaded and fired once. Some comparison might be made between our 8-inch and 6-inch guns and those of Woolwich and Elswick, and with the same general result.

Now, right here is an illustration of what smokeless powder will do, for a good smokeless powder will make the 40 caliber U. S. guns practically the equals of the 40-caliber Elswick guns just mentioned, as far as perforating power is concerned, but it won't alter the breech action of the United States guns making them into quick-firers capable of firing five shots in two minutes, instead of two shots in three minutes. The Elswick people claim four shots a minute for their new 8-inch gun with the light (210 pound) projectiles!

For some time past we have been turning out new ships with 4-inch and 5-inch guns of the quick-firing type, not using smokeless-powder charges (a grave defect), but with their 6-inch and larger guns of the ordinary pattern of breech-loaders; while Great Britain, France and Italy, to say nothing of the smaller powers who purchase guns of Armstrong, Krupp and Canet, have been re-arming their older ships with quick-firing guns of as large caliber as 6.3 inches and converting their old breech-loaders, including those of 6.3-inch caliber, into quick firers.

Give the *Chicago*, *Baltimore* and such ships new batteries of quick-firing guns and their offensive power is immediately increased four or five fold, at least. The new battleships of the *Indiana* class are simply ridiculously weak in moderate caliber gun-fire, with only four 6-inch breech-loading guns, but give them four 6-inch quick-firers in place of them, and their moderate caliber gun-fire is immediately increased, as in the case of the other ships, four or five fold. All this being so, and I think that no well-informed person disputes it, I would ask, why are we so slow in developing 6-inch and 8-inch quick-firing guns and placing them on our ships

In ignoring the development of private ordnance factories, and confining the construction of all naval guns excepting the small quick-firing and machine guns to the Washington Ordnance factory, have we adopted the best means of keeping in the front rank with our naval ordnance, or developing our resources, ready for an emergency? And is it not fully time for our ordnance experts to be up and moving in a determined manner to join the van?

W. V. B.

The Christmas Number of *Harper's Magazine* will contain part third of "The Martian," with six illustrations from the author's drawings. An entertaining article on "President Kruger" will be contributed by Poultney Bigelow, and Dr. William Jacques will describe the process of obtaining electricity direct from coal. W. D. Howells will give personal recollections of the Autocrat of the Breakfast Table in the article entitled "Oliver Wendell Holmes." Two well-illustrated papers will be those entitled "Wild Ducks and Tame Decoys," by Hamblen Sears, and "How the Law got into the Chaparral," by Frederic Remington. In "a Middle English Nativity," John Corbin will describe miracle-plays performed by strolling actors, in which the English drama had its beginning. There will be six short stories, a "Christmas Carol," etc. The number will be bound in an ornamental cover especially designed in colors by Howard Pyle.

The Operating Mechanism of the New Rock Island Bridge.

The new bridge over the Mississippi River, between Rock Island, Ill., and Davenport, Ia., recently opened for traffic, is a notable structure and has attracted much attention from engineers. It is the third bridge to span the river at this point in the last 40 years. The first bridge on this site was completed in 1856 and was the first bridge over the Mississippi River, and it is interesting to note that in litigation which subsequently arose from the opposition of the "river interest," Abraham Lincoln appeared as counsel for the railroad company.

In 1866 and 1867, Congress passed acts authorizing the constructing of a new bridge and the removal of the old one. The Phœnix Bridge Company was given the contract for the superstructure and in 1872 the bridge was opened for traffic. This bridge was strengthened in 1891 to meet the requirements of the increased traffic and in 1894 an entirely new superstructure and partly new masonry were authorized, and the necessary appropriation made by Congress for the construction. Mr. Ralph Modjeski was appointed Chief Engineer, tenders for the work were received on Aug. 12, 1895, at Rock Island Arsenal, by Col. A. R. Buffington commanding, and the contract subsequently awarded to the Phœnix Bridge Company.

The new bridge has two shore spans of 196 feet 6 inches and 101 feet respectively, five fixed river spans of 256 feet 6½ inches, 220 feet 1 inch, 219 feet 10⅝ inches, 220 feet 1¼ inches, and 260 feet 4⅝ inches, and one draw span of 366 feet 9⅝ inches, making a total length of 1,841 feet 3⅝ inches. It is double-decked, the upper deck carrying two railroad tracks and the lower deck being devoted to a roadway with two street-car tracks between the trusses and two walks for foot passengers outside the trusses. The trusses are 29 feet centers and the total width over the sidewalks is 45 feet. The trusses are calculated to carry a total moving load of 11,360 pounds per lineal foot, of which 8,000 pounds are on the railway floor and 3,360 pounds on the roadway floor. The solid corrugated steel railway floor, together with the guard angles and rail plates, weigh about 940 pounds per lineal foot of the bridge. The draw span, which weighs approximately 2,500,000 pounds, is one of the heaviest ever built.

The operating machinery of the draw was furnished by Geo. P. Nichols & Bro., Chicago, and is of unusual construction. It may be considered under four different headings.

THE SWINGING MACHINERY PROPER.

The rack attached to the tread on the center pier instead of having teeth of the usual form is made of steel with sprockets. On each side of the drum is a vertical shaft, supported by brackets, on the lower end on which are cast-steel sprocket wheels corresponding in pitch with that of the rack, which is 12 inches. These sprocket wheels carry an endless chain with links of 12 inches pitch that engage the sprockets on the rack. On the upper end of these two vertical shafts are other sprocket wheels connected by chain to vertical driving shafts which rise up to the floor of the machinery-room. An interesting feature of this part of the construction is the fact that all these vertical shafts are run on ball step bearings. On the upper end of these main vertical shafts and on a level with the machinery room floor are gears, one looking up the other looking down, the two being connected through pinions with a horizontal cross-shaft divided in the center, where an equalizing gear is attached. By means of a train of of gears a 50 horse-power electric motor is connected with the shaft, thereby transmitting the power from the motor to the rack on the masonry.

RAIL LOCKS.

On the ends of the railway track on the draw is a system of rail locks consisting of heavy steel slides fitted to the outside of each rail and held in position by guides so that they may be run out or be withdrawn. When in the locked position they connect the ends of the rails on the draw with those on the fixed span, so that the wheels of the train will pass over the intervening gap on these latches, thereby eliminating any jar, as a continuous track is presented to the wheels. These latches are set and withdrawn by means of a pneumatic cylinder near each end of the

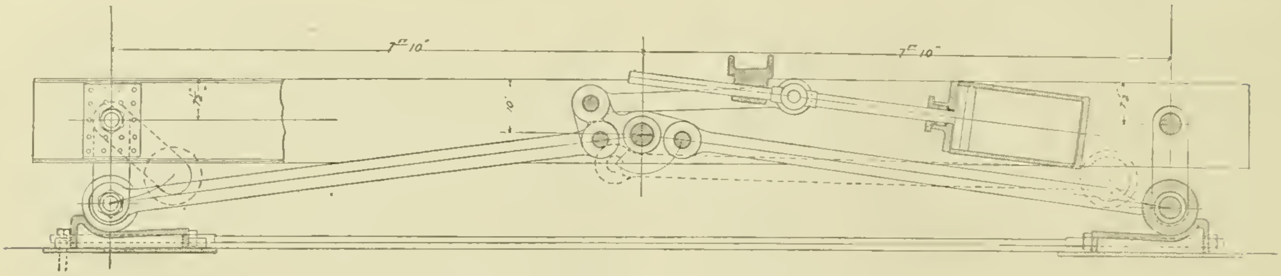


Diagram of End Jack Mechanism of the Rock Island Bridge.

draw, each connecting by a system of rods to all four latches at its end of the draw. The two cylinders are controlled simultaneously.

THE END JACKS.

The jacks themselves are the semi-toggle type consisting of two pairs of bars attached to each end of the end beams directly under the corners of the bridge. These are connected with the end beams by pins, while on the lower end are rollers which bear on bearing plates on the abutments. By means of a pneumatic cylinder and connecting struts these jacks are forced to a vertical position when the bridge is closed and are drawn in so as to release the bridge when it is to be opened. The principle of the construction is shown in the diagram given herewith.

The New Rock Island Bridge.

THE INTERLOCKING AND CONTROLLING SYSTEM.

A Hall signal is placed on each of the fixed spans within a few feet of the ends of the draw which nominally stand at danger. Connected to each of the jacks and rail locks are electric switch boxes from which wires run to an indicator in the machinery-room. When any one or all of the jacks or rail rocks are in a closed position a red lamp is lighted in the indicator, one lamp for each jack or lock, and when they are released for the bridge to swing a white lamp is lighted, replacing the red. By a combination of electric connections, the man in charge of the draw can set the signal to safety only when the heavy jack and locks are set. Thus, if for any reason the bridge is not properly locked the engineer cannot receive his signal to enter upon the draw.

CONTROLLING DEVICE.

In the front end of the machinery-room, in a bay window from which the operator can see the tracks and the river, is placed a controller consisting of four levers. The first one to the right operates a band brake applied to the machinery. The second lever controls the rail locks and can be moved at will. This being thrown forward, the lever controlling the end jacks, previously locked, is released. The movement of this latter lever unlocks the motor controller lever, which now being free can be moved for operating the bridge. This system makes it impossible for the operator to swing the bridge until first the rail lock and then the end jacks have been released, the indicator above referred to announcing to the operator that these various devices have gone through their movements. Inside the machinery-house is a compressor driven by an electric motor and in the attic above the machinery-room are two steel reservoirs of a combined capacity of 200 cubic feet, from which air is drawn to operate the various devices referred to. A uniform pressure of 120 pounds is maintained automatically by the pump.

The electric current for swinging the bridge is furnished from the power station of the Tri City Railway Company, whose wires pass directly over a support on the bridge, also from the People's Power Company, of Moline, whose wires are brought up to the same support on the bridge. By means of a system of rings and brushes current is taken over these wires and brought up to the switchboard in the machinery-room, where a double throw-switch is placed so that the motor may be connected either with the railway wires or those of the People's Power Company.

Compressed Air in Shops.

In the last month three valuable papers on compressed air have come to our desk. One of these was presented by Mr. J. Davis Barnett, of the Grand Trunk Railway, to the Canadian Society of Civil Engineers; another valuable contribution to the literature on the subject is the paper by Mr. Curtis W. Shields before the New York Railroad Club; and the third paper was presented to the Western Railway Club by Mr. J. H. McConnell, of the Union Pacific. We regret that the demands on our space this month do not admit of a full synopsis of these papers; as it is, we will refer briefly to them, and our readers who want complete copies can obtain them from the secretaries of the societies mentioned.

Mr. Barnett goes into the subject at considerable length. On the question of efficiency he says:

The author does not intend to say that air, for continuous work in plate flanging, or for high pressures in stamping and forging, is a more economical transmitter of power than water, or that pipes, air engines and motors are better or cheaper than wires and electric motors, or independent air-driven tools than steam applied through shafting and belts to a compact group of machine tools, but he is of the opinion that if many widely scattered, different and intermittent operations are to be performed; if a cold climate has to be fought; if the technical skill and knowledge of the workman employed is limited; and if the special and portable tools are more or less of home design and manufacture to suit the particular and limiting conditions of their use, then air has efficiency, economy and a wide field of usefulness.

After discussing various types of compressors he has the following to say about storage and pipes:

The shop piping or main for ordinary pressures (80 to 100 pounds, should not be less than 1½ inches diameter, the larger the better. The author having 4-inch pipe to spare on hand, used it with great satisfaction, as it gave ample storage and little friction. Very slight provision is required for drainage. The main is best carried on the top of the roof tie-beam, and from the first should be liberally supplied with short branches and outlet valves, at least one to every 18 or 20 feet, with screwed ends to fit the union nuts of the flexible hose, the hose for hand tools and hoists varying from ⅜ to ½ inch diameter. Cords from the outlet valve lever run down to within seven feet of the floor, controlling the position of the valve. Reservoir storage has to be proportionately, the larger the more intermittent the work done. The pipes and reservoir together should be capable of holding the total delivery of the compressor (working at normal speed) for half an hour, which is far cheaper than providing an excessively large size compressor, cheaper not only in first cost but in daily working. This refers to steam-power compressors.

Mr. Barnett then shows how great is the saving in labor by the use of compressed-air appliances, and proceeds to discuss rotary and reciprocating piston motors. He considers that while the use of rotary motors has been stimulated by the introduction of air, little advance has been made in their design. They are wasteful of air but their convenience retains them in use. He uses portable double acting vertical engines, with cylinders 3½ by 6 inches, running at 225 revolutions. He reheats the air as follows:

Just before it enters the valve chest, it is passed through a 30-inch length of thin copper pipe, ⅝ inch outside diameter, bent into a four-turn truncated coil, barely 3½ inches diameter at base and 2¼ inches diameter at top, contained in a tin lamp 12 inches long, by 3½ inches diameter at bottom and 1½ inches diameter at top. The lamp cistern carries a double "B" burner, using two ⅞-inch flat wicks, and burns an imperial pint of common coal oil each 30 hours. No glass chimney is required, and the flames come close to inside of coil. This lamp it bolted on close to and parallel with the cylinder, and is cheap, neat and inconspicuous, working satisfactorily, even when the engine is set at an angle of 15 or 20 degrees out of vertical.

The paper by Mr. Shields is devoted largely to a consideration of the economical compression of air. The losses due to heating during compression, to clearance in the cylinders, and to friction in the compressor are all discussed at length, and the methods by which these losses are reduced to a minimum in the modern first-class compressor are pointed out. Diagrams of isothermal and adiabatic compression are given, also curves of volumes, pressures and temperatures; tables of temperatures and heat losses in compression carried to various pressures; tables of air used in motors per indicated horse power, and much other valuable data of a similar character. Various authorities are quoted on the cost of compressing air, reheating and other features of good practice. The cost of 1,000 cubic feet of free air compressed to 100 pounds (gage pressure) is given as 5 cents, including all charges and with coal at $4 per ton. Reheating is considered of great importance where motors are used continuously for any length of time, and a horse power at the reheater can be obtained for one-eighth the fuel required for a horse power at the compressor. The advantages of multiple-stage compression are elucidated, and the paper closes with a quotation from the practice of Mr. McConnell, in the Union Pacific shops, showing the saving per day in labor at various points in the shops where air is used.

Mr. McConnell's paper comes to us just as we go to press, and in terse language gives many valuable hints on the application of air. Lifts, jacks, drills, staybolt cutters, and many other devices are mentioned; also the use of air for driving emery wheels, for blowing out cylinder passages, for moving locomotives between the erecting shop and roundhouse by charging their boilers with air, for driving scrap shears, for stamping in the tin shops, for the blast of portable forges, for operating portable engines, for raising sand in the sand-houses, for kindling locomotive fires, for the blast for fires in the blacksmith shop, etc., etc. These are all touched on and enough said about them to show how the applications can be made by those who desire to extend the use of air in their own shops.

The *Street Railway Review* of Chicago will on January 1, 1897, begin the publication of a foreign edition which for the present will appear quarterly. The interest now manifested in other countries in the use of electricity for street railway work is the immediate occasion for this step, as it is believed that the development of that industry in the United States, and the experience gained here, should prove valuable abroad, and should predispose managers and engineers to favor American methods, systems and special devices. This is a reasonable expectation, and we wish our contemporary success in its new venture, and American manufacturers an influx of foreign orders as a result of it.

Powerful Compound Locomotives for the Northern Pacific Railway.

The Schenectady Locomotive Works are building for the Northern Pacific Railway Company four Mastodon or 12-wheel compound locomotives, which will be the most powerful engines of this type ever constructed.

The engines are of the Schenectady two-cylinder compound type, the high-pressure cylinder being 23 inches and the low-pressure 34 inches in diameter, with a stroke of 30 inches. The cylinders are fitted with the new intercepting valve, designed by the Schenectady Locomotive Works, which enables the engine to be operated as simple or compound at will, this device now being in very successful use.

The weight of the engine will be about 180,000 pounds, with 148,000 pounds on drivers. The driving-wheel centers are of cast steel, 48 inches in diameter, which with 3½-inch tires makes the diameter of drivers 55 inches.

The boiler is of the extended wagon-top type, 72 inches in diameter at the front end, has a larger heating surface than ever used in locomotive practice, and is built to carry a working pressure of 200 pounds.

Discipline Without Suspension.

In an excellent paper on discipline Mr. H. S. Mitchell, Division Superintendent of the Kansas City, Fort Scott & Memphis Railway says that when discipline without suspension was first tried on his road he was doubtful of the efficacy of the system in dealing with men who take no pride in their work. He found afterward that it was just this class of men on whom the discipline had the greatest effect. He says: "But how about the man who is generally careless, who does not take pride in his work? It was on this very point that I was doubtful myself, and when the circular to Memphis employees announcing the change of discipline was being prepared, I urged the insertion of the following clause: 'Suspensions will be imposed when the head of the department deems disciplining by marks unsuitable to the case or to the individual.' But with the experience I have since had, I am perfectly willing to surrender this reservation, believing now that uspensions are not necessary to effect proper discipline among, even second-rate men. In fact it is this class that seem to take the matter most seriously, evidently looking upon it as a scheme of their superiors to get rid of them. They, of course, regarded suspension as an undesirable thing, but entertained the idea that, having undergone a suspension, they were thereby purged of all guilt and entitled to a fresh start. They now realize that while they escape suspensions, the offenses that were formerly punished in that way are treasured against them, and that eventually each offence, treated so indulgently at the time of its commission, will contribute in a measure to causing their dismissal. They discover that trivial offenses, never considered sufficient to warrant suspension, are now recorded and are liable to prove the straw that breaks the camel's back. Perhaps in no other particular is the advantage of the new system so pronounced as in the matter of disciplining for small irregularities, and as a result we observe a marked decrease in the number of slight, but vexatious, blunders. Another desirable feature is the opportunity afforded an officer to reverse or amend his ruling in particular cases, if, after the lapse of time, he finds that he has erred, or that evidence not obtainable at the time of the original investigation places the matter in a different light."

One of the elevators in the American Tract Society's 23-story building in New York City, one day last month dropped 140 feet at a speed just too slow to throw the safety clutches into action. The elevators are on the high-pressure system and have given considerable trouble. They have a total lift of 267 feet 7 inches, and a speed of 700 feet per minute. The trouble with the high-pressure system is said to be that the small volume of water required for the work makes fine regulation very difficult and the new valves designed for the system have not worked as well as expected. The immediate cause of the accident was the blowing out of packing by which the water was allowed to rush out of the cylinder. The elevators are to be altered over to the low-pressure system.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING..NEW YORK.

M. N. FORNEY, W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

DECEMBER, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

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

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

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

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

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

There appeared in our columns last month an abstract of a comparison between steel-tired and cast-iron wheels, presented recently to the Southern and Southwestern Railway Club. By that comparison the steel-tired wheel was shown to be much less economical than its competitor. There is no doubt that for many kinds of service the cast-iron wheel is the cheaper of the two, but it is a question if the difference is always as great as the figures given in the comparison referred to would indicate. To make a comparison upon the mileages guaranteed the respective wheels is not so accurate a method as if the actual average mileages are taken, unless it can be shown that the guaranteed and actual mileages bear the same ratio to each other. There are those who believe that the actual mileages of the steel-tired wheels exceed their guarantees to a greater degree than do cast-iron wheels. There is also the number of wheels discarded because of flat spots or other defects to be considered, and which does not seem to have been taken into account in the paper mentioned. The question of safety is also an important one, and while the high-grade cast-iron wheel is a product that does credit to the foundryman, and is remarkable for its freedom from fracture in service, there are positions in which railroad men are loath to trust it. In heavy fast passenger service the coaches will be found to be carried upon steel-tired wheels, even if the cast-iron wheels are used under other coaches on the same road. The truck wheels of fast passenger engines are steel tired. Freight engines may have cast-iron truck wheels when the leading trucks have four wheels, but if the engine is of the Mogul type a steel-tired wheel is often substituted. Other cases might be cited, but these are sufficient to show that reliable as is the cast-iron wheel when properly made, the steel-tired wheel is considered preferable under conditions that are unusually severe. We are of the opinion that if accurate statistics on the safety and service of the two types are collected for various classes of service, instead of lumping them all together, the results will show that railroads have good reason to use steel-tired wheels in some classes of service, and that there is a wide field of usefulness for both types of wheels.

An important movement having for its purpose the establishment of standard 60,000-pound box car, into which shall be incorporated all the Master Car Builders' standards and recommended practices, has been inaugurated by the Ohio Falls Car Manufacturing Company, of Jeffersonville, Ind. That company does not expect that this movement will change the standards of large systems, but it may be instrumental in bringing about a uniformity in the freight car equipment that is hereafter to be required by smaller roads and private companies, who wholly or in part accept the specifications of the builder. Such a result is well worthy the hearty co-operation of every railroad company and of Master Car Builders and foremen, as every shop must repair these cars, and they should welcome any progress toward simplifying their present diversity. The other car building firms throughout the country have been invited to join in the movement and to signify their preferences in the following dimensions of the proposed standard: Length, width and height, in the clear inside; door opening; center to center of body bolsters; section of each sill, end sill and plate; height of lining; diameter and ends of truss rods; wheel spread; section and set of each arch and tie bar; diameter of column and oil box bolts.

The originators of this plan believe that this movement will result in creating a uniformity among the contract car works, primarily of the parts mentioned, and later of many of the less essential parts, as well as of the details of fruit, coal, stock and flat cars. The standard can be kept up to date by incorporating all standards as successively adopted or recommended by the Master Car Builders' Association or by the united judgment of the manufacturers. The plan is to be commended, and we think it would be a fortunate thing for the railroads of this country if it should ultimately result in a standard design in which each and every detail is included and which would be followed by more than the small roads. The large roads should be interested in this movement by reason of the prospective reduction of the diversity that now exists; and if the movement succeeds their passive interest may turn to an active one and they may be induced to join it. They have frequently been urged to take steps themselves toward the adoption of a standard car, but as yet have failed to do so. In fact, they have never seriously entertained the matter, and so we have in the country a million and a quarter of cars of thousands of different designs, few of them confined to any one locality, and some of nearly every design, ultimately passing through every repair shop in the land. There is no necessity for so many designs, particularly in the cars that are extensively interchanged, and if wisely designed standard cars are once thoroughly established their adoption ought to extend rapidly. The movement inaugurated by the Ohio Falls Car Manufacturing Company is deserving of hearty support.

DEFECTS AND IMPROVEMENTS IN LOCOMOTIVES.

III.

In our September number this subject was partially discussed with an announcement that its consideration would be resumed in a future number. The sources of waste which were then pointed out were imperfect combustion, due in part to bad firing; defects in grates and small fireboxes, and to the excessive temperature of the escaping chimney gases and the heat in the exhaust steam. The remedies which were then suggested were the improvement of firemen, larger fireboxes and grates, variable grates in which the live and dead portions could be varied at pleasure and devices which would bring about a more intimate contact of air with the fuel to be burned, feed-water heaters and steam superheaters. Down-draft grates were also proposed as worthy of investigation.

The great deficiency in most of our large locomotives of the present day is in the size of their fireboxes. With our bar frames 3 or 4 inches wide, if the firebox is placed between the frames, the width of the grate cannot exceed about 35½ inches. If the firebox is placed above the frames the grate may be about 8 inches wider, but the depth over it must be considerably reduced. The Wooten type of firebox, which is placed entirely above the driving wheels, can then be made as wide as the widest part of the engine, but it must then be very much reduced in depth. This is in a measure compensated for, in some cases, by making it long and using a bridge wall and thus forming a combustion chamber at the front end. Still the fact remains that the fire, in this kind of firebox, and in less degree in the so-called "toboggan" form, which is above the frames, is brought comparatively near to the crown-sheet. Now, in any fire, but especially one which is burned as rapidly as that in a locomotive grate is, it is very important that the process of combustion should be as near completed as possible *before* the flame or gases come in contact with the heating surfaces. Such contact undoubtedly partially arrests combustion. Plenty of room in the firebox, especially above the grate, is, therefore, regarded as a matter of much importance, and as promotive of good combustion.

Twenty-five or thirty years ago the standard passenger engine in this country weighed about 30 tons, and had about 15 square feet of grate and about 800 square feet of heating surface. Now our passenger engines, many of them, are of double that weight, and have twice that amount of grate and heating surface, and the average speed of trains has been increased about 50 per cent. and their weight doubled. To haul twice the weight at a given speed will require double as much steam and at a speed 50 per cent. greater, the train resistance will be increased about one-third. Now, if the old 30-ton engines burned 24 pounds of coal per minute to haul their trains at 30 miles per hour, the big engines should burn twice as much, or 48 pounds, to haul a train of double the weight. If, besides, the speed is increased 50 per cent., the quantity of steam consumed in a given time would be in the same proportion, which would require a consumption of coal of 72 pounds per minute, and as the train resistance would then be one-third greater at the increased speed, we would have a total consumption of 96 pounds of coal per minute. That is, with double the grate and heating surface, we must burn four times the quantity of coal in a given time that the old engines did. The figures are, of course, only assumptions and are used merely as illustrations, but they will explain, what has often been remarked, that our modern locomotives do not do the amount of work in proportion to their size that the old engines did "before the war." In other words, the locomotives of to-day are deficient in boiler capacity. Now, how can the boiler capacity be increased? Obviously the limitations are those of space and weight. We are confined in width and length and height, and the weight which can be carried on each wheel must not exceed a certain amount. The problem is a very old one, and the ingenuity of designers of locomotives has been exercised on it ever since the latter have outgrown their limitations. The plan, which seems to be a solution of the difficulty—at least in the case of passenger engines—is that embodied in the "Columbia" type of engine, in which the driving-wheels are all placed in front of the fire-box and the overhanging weight of the latter is carried on a pair of small trailing wheels. By depressing the frames back of the driving-wheels and carrying them below the firebox, it can be made of a reasonable depth or height, and of any width desired. But if the wheels are large, say 7 feet diameter, even if they are placed as close together as is practicable, the boiler, if arranged as in ordinary locomotives, must be very long and the tubes will be about 15 feet in length, unless the front tube sheet is set back farther than is customary. While long tubes would have the advantage that they would facilitate the use of the method of heating feed-water, which was described in our preceding article, and would give considerably more heating surface, their greater length and that of the boiler would increase its weight very materially. The problem, then, is how to reduce the weight either of the boiler or other parts of the locomotive so that its total weight will not exceed the limits to which it must of necessity be confined?

We are thus confronted with very much the same problem which Ross Winans wrestled with in the early days of the Baltimore & Ohio Railroad, when he first began to build eight-wheeled coupled engines for that road, which had very sharp curves and heavy grades. His "camel" engines had wheels 43 inches in diameter, and a total wheel base of 11 feet 2½ inches. All the axles run in front of the firebox, the outside width of which was just sufficient to allow its front end to go between the back pair of wheels. The boiler had 103 tubes, 2½-inch tubes 14 feet 1¼ inches long. The grate was 7 feet long by about 42 inches wide. The weight of engine with water and coal is given at 24 tons; whether long or short ones does not appear in the records available. The diameter of boiler was 46 inches. The heating surface in the tubes was 903 square feet, and in the firebox 86½, or a total of 989½ square feet. With that size of boiler and weight of engine, it will be seen that it was not an easy problem to keep the weight down to the limitations to which they were then confined. The top of the firebox was therefore made to slope downward from the point where it joined the waist of the boiler to the back, and the top was made flat and stayed with ordinary stay-bolts. It is doubtful whether any locomotive boiler of equal capacity was ever made which weighed so little. Unfortunately its weight is not now known. It is true that many of them exploded, but that was probably owing to the deficient staying at the base of the dome, which was very large, and located just back of the front tube-sheet. This same form of firebox was afterward adopted and is still extensively used in the Pennsylvania Railroad, although no new engines with boilers of that form are now built. It has given excellent service, and by those who have had the best opportunities of learning and knowing, the writer was recently told that there was no boiler on the road which weighs and costs so little, in proportion to its capacity or is so economical to maintain or has given better service than this. Some of them were originally made too small, which was not a defect in their form, but in their proportions. There can be no doubt that a very material saving in weight can be effected by using this form of boiler.

There is another consideration which has not a sufficient amount of attention in locomotive designing, which is, that for every pound of weight saved in the other parts of the machine, a pound may be added to that of the boiler. The substitution of steel and wrought-iron parts for those heretofore made of cast iron has made a very great economy in this direction possible, and it seems certain that if a skillful designer should carefully go over every part of any ordinary locomotive and remove all unnecessary material that a very considerable reduction would be possible, without any diminution in strength, and possibly by some intelligent design in some cases an increase in strength. The use of cast-steel wheel centers reduces their weight some hundreds of pounds, and if some genius would devise a method of counterbalancing the pistons, cross-heads, etc., without the use of counter weights, several thousands of pounds more of useless weight could be dispensed with.

An essential requirement in locomotives of to-day is larger fire-boxes and greater boiler capacity. The plan of placing the driving wheels all ahead of the fire-box, and carrying it on a pair of trailing wheels, enables the fire-box to be increased in width without material diminution in depth. The old discarded and discredited, but nevertheless efficient, form of fire-box described, will permit of a very material diminution in weight over any other form in use. There is also the consideration that the nearer an apartment approximates in plan to a square the smaller will the walls be for a given enclosed area. Thus supposing we have a grate 4 by 12 feet the length of the enclosing walls would be 32 feet and the enclosed area 48 square feet. If the grate was 8 by 8 feet the enclosing walls would have the same length, but the area would be 64 square feet instead of 48. The enclosing walls of a fire-box which is nearly square, will, therefore, weigh less for a given grate area than they would if the grate is long and narrow. This same principle applies with reference to the cubical contents of a fire-box—an important matter. The nearer it conforms to a cube, that is, the nearer the length, breadth and height are alike, the lighter will be the enclosing walls in proportion to its cubical contents.

Of course, if it was practicable to make a fire-box spherical in form, it would be the lightest possible shape that could be adopted. It will be seen, then, that the "Columbia" plan of engine not only permits the fire-box to be enlarged laterally and vertically, but it may at the same time be made lighter for a given area of grate. By adopting the Winans' or camel fire-box, with the "Columbia" type of engine, the weight which overhangs behind the driving axles could be lightened, or, conversely, its size may be increased without adding to its weight. The purpose of this article, then, is to call attention to the advantages which are inherent in the "Columbia" plan of engine and the camel fire-box or something similar to it.

The subject of this article will be taken up again in a future number.

THE PROSPECTS FOR ELECTRICITY ON STEAM ROADS.

In discussing last month the immediate prospects for electricity on steam roads we referred to the paper on the subject which had been presented before the electrical engineers in October and the discussion which took place thereon. Mr. Emery, in his paper published elsewhere in this issue, says that the use of electricity for long-distance traffic is feasible, and the real question is whether it will pay. He shows that in city and suburban traffic electricity is an established success and one feature of it is the increased travel which has been created by it. In long-distance traffic he holds there is little probability of increasing the amount of travel and that electricity must compete with steam on the basis of the same amount of business for both. He further believes that the electric locomotive for high speeds will eventually resemble the steam locomotive more than it does now. In his opinion it will be advisable to mount the motor separately and gear it to a shaft from which the power will be transmitted to the driving wheels by connecting and parallel rods. The leading truck he also believes will be needed to give flexibility and security at high speeds.

So much for the conditions of the problem and the tendencies in electric-locomotive construction. He then proceeds to compare the actual figures for an Eastern trunk line with a possible electric installation to handle the same traffic. The first item of importance in many of the discussions on this subject is the saving in fuel, but he shows that on the steam road the fuel bill is only 10 per cent. of the total expenses and that, therefore, if one-half of it was saved the actual reduction of expenses would be only 5 per cent. As an actual fact this saving will be swallowed up by fixed charges and an additional traffic of from 10 to 12¾ per cent. will be needed to wholly meet these charges.

In the discussion which followed, these figures were not challenged, but there appeared to linger in the minds of several prominent electricians the hope that if electricity did not pay in dollars and cents in such traffic it might ultimately succeed because of other advantages accruing from its use, such as increased power and greater speed than is possible with the steam locomotive, and the possibility of more successfully operating traffic in small units. Now, much as one may desire to see electricity a success in long-distance traffic, nothing is to be gained by glossing over facts, which is what is done by those who present such arguments.

Take the question of the weight of trains. The tendency toward heavier train loads is one of the characteristics of the progress being made toward cheaper transportation on steam roads to-day, and it is based on sound principles. As Mr. Emery shows, the fuel consumption is but about ten per cent. of the operating expenses, and experience shows that heavier trains in general reduce the other operating expenses, such as wages, etc., more than they increase the fuel consumption. Instead of undertaking the long-distance traffic with reduced train loads, the electrician should in most cases be prepared to haul heavier trains than at present. The strenuous efforts now being made by railway managers to get more tonnage in each car and more cars in each train is a fact the significance of which should not be overlooked.

As to the increase of speed possible with the electric motor, it is of questionable utility. Increased speed always means increased cost, and there seems to be no reason why this should not apply equally to electricity and steam. On this assumption, it is reasonable to suppose that the increased speed is not wanted for freight service, and if wanted can be obtained with steam as readily as electricity. In passenger service the steam locomotive can attain any reasonable speed, and the enormous velocities claimed to be possible with electricity would call for such large expenditures for brakes, signals, etc., as to render the speeds impracticable, particularly if the slow-moving freight trains are to be operated on the same line.

Nor does the claim for greater power in the electric motor seem well founded. If the weight of the locomotive can be increased, greater power can be obtained with steam. Unless it can be shown that for a given weight the electric locomotive can develop more power than its competitor, the greater power is not available. The experience thus far gained would seem to indicate that instead of weighing less, the electric motor will weigh more when it carries all the accessories that are necessary for economical operation.

It is matter of regret that any prominent electricians can be found who are ready to defend such an unmechanical affair as the Heilmann locomotive, or to express the belief that some good may come from the experiments with it, as was done in the discussion referred to. The motive power at the head of a train is fairly satisfactory when it consists of a boiler and a steam engine, and it may be a success when it is made to consist of an electric motor, but when it carries all of these and dynamos in addition it is doomed to failure.

The conclusion seems inevitable that electric motive power, to be successful in long-distance travel, must be superior to steam in dollars and cents, and must haul trains of the present, or heavier, weights on existing schedules.

The idea that compressed air mixed with steam in the cylinder of a steam engine would be productive of economy has been endorsed in times past by engineers of eminence. Some ground for this belief exists in the known fact that the presence of the air in the steam decreases the amount of cylinder condensation. To find the exact effect of such a mixture upon the economy of an engine tests were recently undertaken at Stevens Institute (and published in the *Stevens Indicator*), the engine used for the purpose having a single cylinder $7\frac{5}{32}$ inches in diameter and 14 inches stroke, running from 200 to 228 revolutions per minute and cutting off at one-quarter of the stroke. The tests were in four series, as follows: 1st, Tests 1 and 1*A*, using steam alone; 2d, Tests 2, 2*A*, 3 and 4, using air and steam, the air at a temperature of 70 degrees; 3d, Tests 5, 6 and 7, using steam and air, the air being heated to about 540 degrees Fahr., corresponding to the temperature of adiabatic compression; 4th, Tests 8 and 9, under the same conditions as 5, 6 and 7, except that the air orifice was enlarged to twice its original diameter. The steam-pressure averaged about 90 pounds. In series 2 and 3 the air entered the steam-pipe through a hole $\frac{1}{10}$ inch in diameter and in series 4 the orifice was $\frac{1}{5}$ of an inch. The air admitted varied from $1\frac{1}{2}$ per cent. (by weight) of the steam to $8\frac{1}{2}$ per cent. The indicated horse-power averaged about 20. The water per indicated horse-power, without air, averaged 32 pounds. When air was used it averaged 30.7 pounds. The best results gave a saving of about 7 per cent., but this is almost exactly offset by the power required to compress the air, so that the saving per net horse-power is *nil*.

Personals.

Mr. H. T. Woods has been elected General Manager of the Tabor & Northern Railway.

Mr. W. W. Noble has been appointed Purchasing Agent of the Huntington & Broad Top Railway, vice Mr. S. B. Knight, resigned.

Mr. Joseph S. Harris has been chosen President and Mr. William R. Taylor Secretary of the reorganized Philadelphia & Reading Company.

Mr. George Hafer has retired from the presidency of the Cincinnati, Lebanon & Northern, and is succeeded by Mr. Joseph Wood, of the Pennsylvania lines.

Mr. George C. Gorham, of Washington, for many years Secretary of the United States Senate, has been elected a Vice-President of the Northern Pacific Railroad.

Mr. W. W. Tomlinson has been appointed Chief Engineer of the New Orleans & Western, with headquarters at New Orleans, La., to succeed Mr. C. B. Deason, resigned.

Mr. J. T. Odell has resigned as Second Vice-President of the New England Railroad, so that he can devote all his time to the Butler & Pittsburgh, of which he is President.

Mr. Wm. H. Stocks has been appointed Division Master Mechanic of the East Iowa Division of the Chicago, Rock Island & Pacific Railway, with headquarters at Rock Island.

Mr. Volney T. Malott, of Indianapolis, Ind., has been appointed Receiver of the Vandalia system. Mr. Malott is Chairman of the Board of Directors of the Chicago & Western Indiana.

Mr. B. A. Denmark, of Savannah, has been elected President of the Southwestern Railway, to succeed the late President Baxter. Mr. Denmark has been a Director of the Central of Georgia.

The Marietta & North Georgia road has been reorganized as the Atlanta, Knoxville & Northern, and Henry K. McHarg has been elected President, Mr. Eugene C. Spaulding, Vice-President, with headquarters at Atlanta, and Mr. Joseph McWilliams, General Manager, with headquarters in the same city.

Mr. John M. Egan has been elected Vice-President of the Central Railroad of Georgia and will have his headquarters at Savanah, Ga. Mr. Egan has occupied many important railroad positions with ability, among them the Presidency of the Chicago Great Western, and in that position he was the Agent of the General Managers' Association at Chicago during the Debs strike.

Mr. George F. Ely, Secretary and Treasurer of the Cleveland City Forge and Iron Company, died suddenly on Oct. 28. Mr. Ely began his business career in the office of his father, who at that time was Treasurer of the Lake Shore road. In 1864 he entered the firm of Coe, Ely & Harman, which in 1871 was incorporated as the Cleveland City Forge and Iron Company. At the time of his death he was also interested in several other manufacturing interests.

The promotion of Mr. Atterbury from Fort Wayne, to be Superintendent of Motive Power at Altoona has led to several other changes in the Mechanical Department of the Pennsylvania system. Mr. Bernard Fitzpatrick, Master Mechanic of the Pennsylvania lines at Columbus, O., has been appointed Master Mechanic at Fort Wayne, Ind., to succeed Mr. Atterbury; Mr. Thomas F. Butler, Master Mechanic, at Wellsvile, O., has been ransferred to Columbus, O., to succeed Mr. Fitzpatrick; Mr. George P. Sweeley, Master Mechanic at Crestline, O., has been transferred to Wellsville, O., and Mr. P. F. Smith, Jr., Assistant Master Mechanic, of the Fort Wayne shops, has been appointed Master Mechanic at Crestline, O., to succeed Mr. G. P. Sweeley.

Gen. Joseph T. Torrence, well known in railroad circles through his connection with the Chicago & Western Indiana road and through the part he took in track elevation in Chicago, died in Chicago, Oct. 31, in the fifty-fourth year of his age. He was born in Mercer County, Pennsylvania, and was early thrown on his own resources. He was working as foreman in the Briar Hill iron furnaces at the opening of the war, which position he resigned to enlist in the army. After his return from the war he took charge of iron furnaces in Pennsylvania and in 1869 went to Chicago as Manager of what is now the Union Works of the Illinois Steel Company. From that time on he was interested in many iron plants in the vicinity of Chicago. He also in the early eighties took the presidency of the Chicago & Western Indiana and helped to build up that line. He was also one of the promoters of the Chicago & Calumet Terminal Railway. In recent years his magnificent scheme to construct an immense elevated terminal system for all the roads entering Chicago from the south brought him more prominently before the public than ever. His terminal plans were not realized, but much of the credit for the work of track elevation since accomplished in that city is due to the energy with which he grappled with the problem.

CONSTRUCTION AND MAINTENANCE OF RAILWAY CAR EQUIPMENT.—IX.

BY OSCAR ANTZ.

(*Continued from page 254.*)

FREIGHT TRUCKS—CONTINUED.

In Fig. 53 is shown a diamond truck which differs in a number of points from those described in the previous articles. The spring-plank is discarded and the two sides of the truck are connected by two channel bars placed vertically, which also form a guide for the bolster, doing away with the usual guide bars and blocks. *A*, *B* and *C* are the arch and tie bars, which are connected together in the usual manner by the arch bar bolts *DD* and journal-box bolts *EE*, a malleable washer *OO* being placed under the heads of the former to allow for good fillet to be left on the bolt. On top of the bottom arch bar at its center is placed the spring seat *FF* lipping over on the sides of the bar, and also lipping up over the outsides of the transoms *GG*. These channel iron transoms are placed between the top of the spring seat and bottom of top arch bar and the whole is securely tied together by means of the arch-bar bolts *DD*, malleable castings *HH* being riveted to the channel bars, and forming a support for the bolts. This casting is extended toward the center of the truck and forms a bracket for the brakebeam hangers. The bolster *II* is of oak in two pieces bolted together and trussed by the rod *JJ*, for which grooves are cut out in each half of the bolster, this rod passes under a deep queen post *PP* at the center and the nuts on the ends rest on large cast-iron washers *NN*, which distribute the

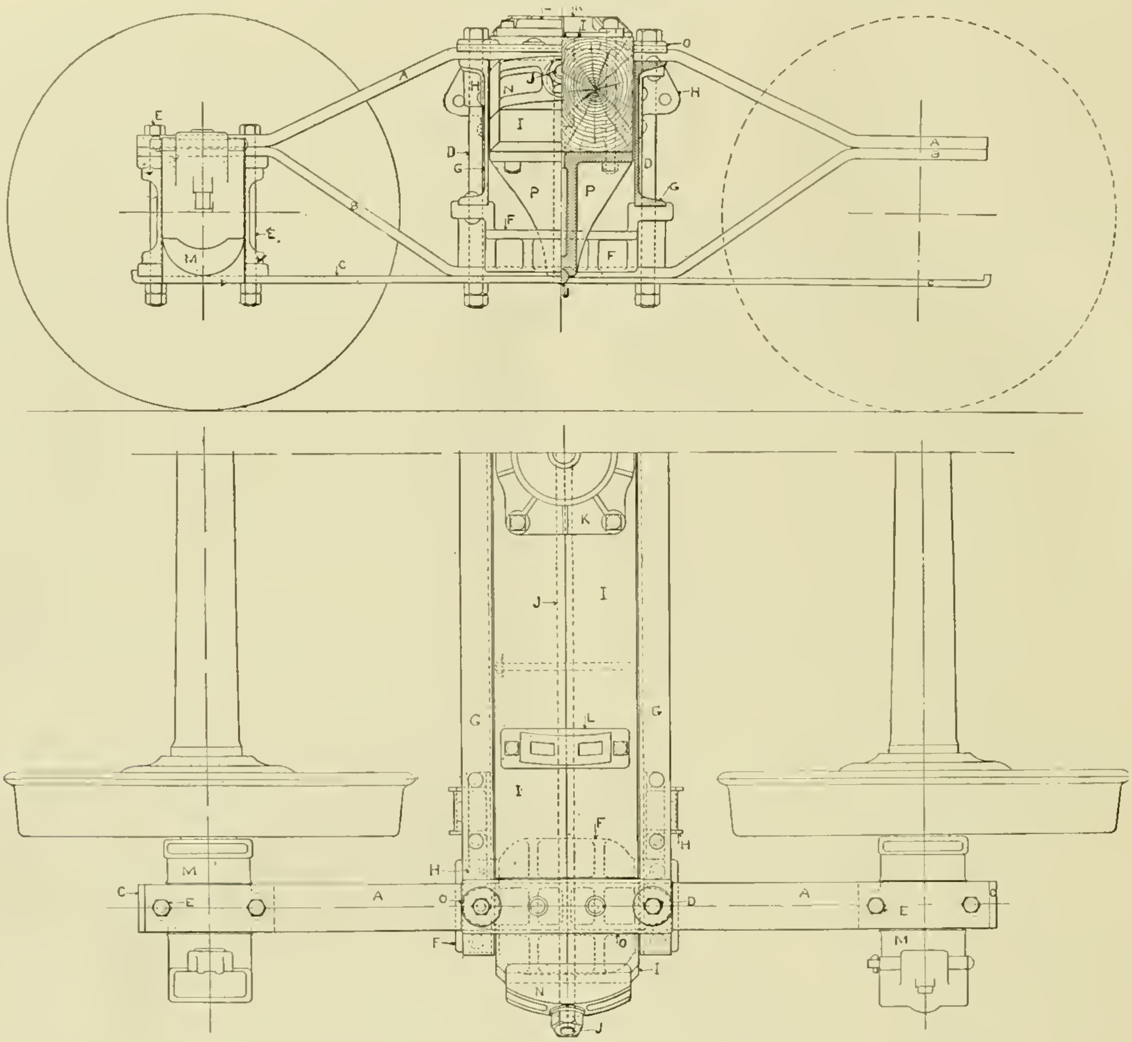


Fig. 53.—Diamond Truck without Spring Plank.

strain over the ends of the bolster. The top of the bolster near the ends is cut down about 2 inches so as to allow the ends to pass under the arch-bars and the shoulders thus formed limit the end motion of the bolster, the side motion being restrained by the transoms. Center plate *K* and side bearings *LL* are provided in the usual manner. The journal boxes *MM*, shown on these plans, are rounded on the bottom, thereby doing away with corners, which would have to be filled with waste and oil which is not utilized in the lubrication of the journal.

PRESSED STEEL IN TRUCK CONSTRUCTION.

On account of the extreme weight of trucks, attempts are constantly being made to lighten their construction without impairing the strength, and pressed steel seems to be the material which allows the greatest reduction in the weight. Bolsters and spring planks made of pressed steel were mentioned in previous articles, and recently arch bars have been introduced which are made of pressed steel of channel construction, instead of solid bars of iron, but as yet these have been so little used that their success is still a matter of doubt.

Trucks, made of pressed steel, and differing in their entire construction from the diamond truck, are being used considerably and have given such excellent satisfaction that many roads have adopted them quite extensively. While the repairs of these trucks, when badly damaged, are perhaps difficult to make, still it is matter of fact that they are not as easily damaged as the diamond truck, and their economy is therefore at least no less. In these trucks the springs are placed directly above the journal boxes and the truck rests on top of these springs, pedestals being provided by means of which the relative position between frame and boxes is retained. The entire frame of the truck is riveted together, forming practically one piece.

In Fig. 54 is shown working drawings of the Fox truck, which is used the most in this country. The side frames *AA* are pressed in the shape of channel-bar section and are riveted to the two transoms *BB*, which are also of channel-bar section, the flanges on the ends being cut off and these ends being turned to form a right angle, providing the means to attach the transoms to the side frames. The two transoms are tied together by the center-stiffener *G* and by the strut *F* and base plate *C*, the two latter also forming a support for the center plate *D*. All these parts are made of pressed steel, and are riveted together. The side-bearings are supported by the side-bearing struts *HH*, which also help to tie together the two transoms. *II* is a bracket for attaching the brake-beam hanger, when inside-hung brakes are used.

The side frames are cut out at the axle centers, to receive the pedestal T's *EE*, which guide the journal boxes in their vertical motion. In the top of these pedestals are placed the top spring seats, which receive the truck springs, and the bottom of the pedestals is tied together by means of the bolts *K* passing through spread pieces *JJ* of cast-iron. All the parts which are made of pressed steel, are ⅜ inch thick, and the rivets used are ⅝ inches in diameter. Brake lever guides and fulcrums and safety chains can be attached wherever desired, as is shown on the perspective views.

Fig. 55 shows another pressed steel truck, the Schoen, which differs greatly from the one just described, in the shape of the separate parts and in the introduction of a stiffening piece of bar iron or steel.

AA are the top members of the frame, which also form the outer legs of the pedestals. *BB* are the bottom members, made of flat bars, and riveted to the top members at the ends over the journal boxes. These bottom members pass down on the inside of the pedestals and under the side frame diaphragms *CC*. The pedestal brackets *DD* are riveted to the bottom of the lower

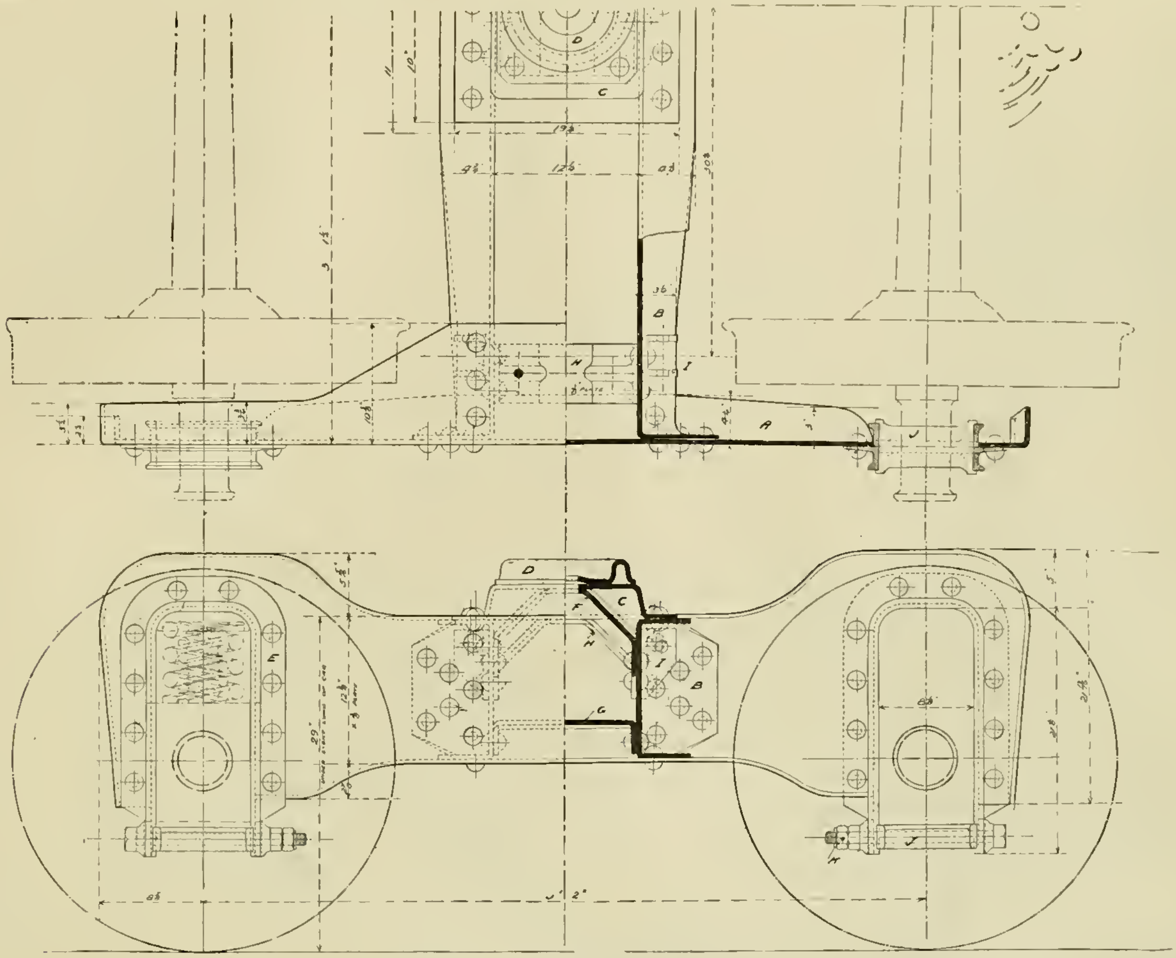


Fig. 54.—Fox Pressed Steel Truck.

members, and with these form the inside legs of the pedestals. In the top of the pedestals are placed the spring caps *EE* and the liners *KK* on the inside of the pedestals form guides for the journal boxes. The pedestal bolts *LL* tie the lower ends of the pedestals together, castings *JJ* forming distance pieces, and washers *RR* being placed under the nuts. At the center the truck sides are tied together by the bolster-channels *GG*, the ends of which are formed into right-angled flanges *TT*, stiffened by the braces *P*, pressed into the plate. The two bolster channels are tied together near their centers by the center braces *HH*, which also form a support for the center-plate. A distance plate *F* brings the center plate to the proper height and distributes the weight over a larger surface. The center plate *II* is made of the usual shape of such plates, made of pressed steel, and the side-bearings, which are shown as castings, are placed directly on the top member of the frame, without any other support. The center braces *HH* are provided at their centers near the bottom with projections *NN*, pressed in, which form a guide for the lower part of the center pin. *MM* are brackets for suspending the brake-beam hangers, when inside hung brakes are used.

BRAKES.

On account of the heavy freight cars of large capacity in use at the present time and the high rate of speed at which freight trains are now run, it is just as necessary, in order to control their speed, to have good brakes on freight cars as it is to have them on passenger trains, and the general adoption of air brakes on freight cars is perhaps only accelerated by a few years by the interstate commerce law, which makes it compulsory to have in every freight train a sufficient number of cars equipped with a brake by means of which the engineer on the locomotive can control the speed of the train independently of brakemen and hand-brakes. This law, together with the acknowledged advantages derived from power-brakes, have brought the air-brake to its present state of perfection, and as a modern car can hardly be considered as complete unless equipped with such a brake, only this kind of apparatus will be touched upon.

The brake equipment of a car can be divided into two distinct parts, the foundation gear and the air-brake proper, the former consisting of the levers, connections, etc., transmitting the power applied for braking purposes to the wheels, and the latter being that part of the equipment by means of which power is delivered from the locomotive to the foundation gear.

FOUNDATION GEAR.

The most important point in designing the foundation gear is to so proportion the parts as to not prevent the wheels from turning when the power is applied, until the momentum of the car has been stopped, or in railroad parlance to keep the wheels from sliding; theoretically it requires a pressure upon any pair of wheels equal to the weight carried by the wheels to slide them and the maximum effect, with safety, will therefore be obtained if the pressure is so adjusted so as to be somewhat less than the minimum weight on the wheels, which is that of the car without any load divided among the several pairs of wheels. The system of levers is therefore arranged in such a manner that with a certain applied power, the total pressure on the wheels will be about 70 per cent. of the light weight of the car, this ratio having been found to be about right for freight equipment.

The arrangement of levers varies with the details of the car and is usually made so as to equalize the pressure on the different wheels and to always put a tensile strain on the connections. When it is possible, the levers and connections are placed in one horizontal plane, which is that of the center line of the air cylinder, and is generally 7 to 8 inches below the bottom of the sills.

On cars having the usual floor-frame, illustrated in a previous article, with no doors, hopples or other attachments on the bottom, the arrangement of foundation brake, shown in Fig. 56, is most commonly used. The power of the air cylinder is applied in the direction of the arrow through the push-rod *A* to the

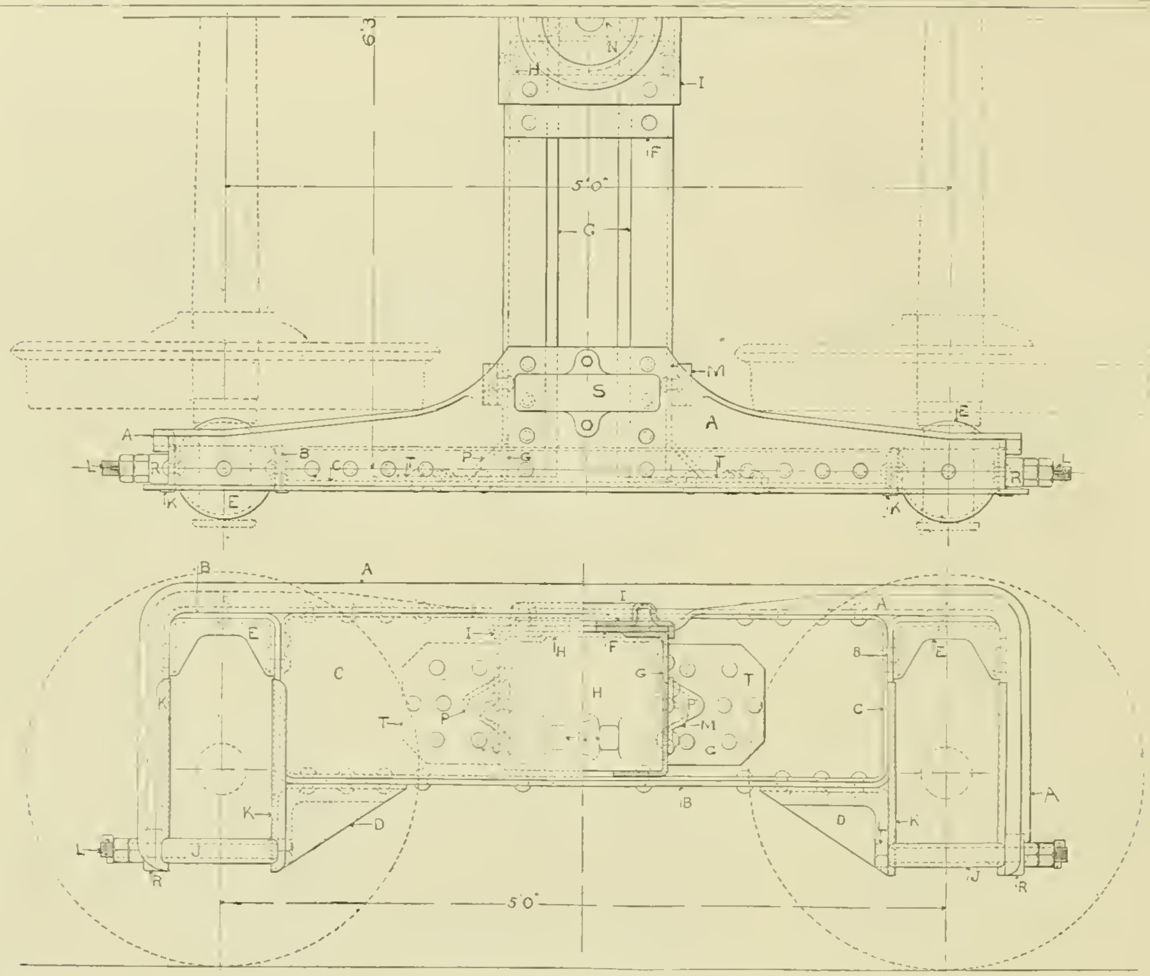


Fig. 55.—Schoen Pressed Steel Truck

cylinder lever *B*, to one end of which is attached the connection *C*, which transmits the power to the track levers, and through these to the brake beams and shoes. At a certain point on the cylinder lever *A*, between the push-rod and the truck-lever connection, is attached the cylinder-lever connection *D*, which transmits power to the floating lever *E*, and through this to the truck-lever connection *F*, which operates the brakes on the other truck. The cylinder lever *A* is extended beyond the point where the push-rod is connected, and to this end is attached the hand-brake connection *G*, the other end of which terminates in a hook over which the chain *H* is passed, which is wound on the brake-shaft when brakes are applied by hand; when brakes are applied by power, the hand-brake connection is moved in the direction of the brake-shaft, allowing the chain to hang down slack. The ratio between the two ends of the floating lever are generally the same as that of the cylinder lever, the actual lengths being sometimes different to suit local conditions. When a hand-brake is used at only one end of the car, the floating lever is fulcrumed at one end, as shown in full lines, the support being made of flat iron secured to the crosstie timber and sills of the car. When hand-brakes are used at both ends, the floating lever is extended same as the cylinder lever, and the other hand-brake connection is attached in a similar manner, as shown in dotted lines. Provision has to be made to allow for the floating lever to be fulcrumed at the proper point when the power is applied at the cylinder lever, and also to allow for this point to be moved when power is applied at the floating lever, and this is accomplished by having the floating lever fulcrum *I* made with a slot, in which the pin through the lever is free to move to suit the conditions. The cylinder and floating levers are supported by the lever carriers *J J*, which are usually made of 1-inch round iron, bent in the shape of a U, the ends being flattened and fastened to the sills of the car by lag-screws. An error sometimes made in putting up these carriers is that of having them not long enough, so that the lever strikes the vertical part before the brakes are fully applied.

The proper effect of a force applied to a lever is obtained with any reasonable angles between the levers and their connections, but the lateral or vertical displacement of the connections arising from the motion of levers at extreme angles is so great that they are liable to come in contact with adjacent parts of the car. Furthermore, while the desired ratio between the two arms of a lever are not altered by any reasonable angle which the lever makes with its connections, providing those connections are parallel to each other, the angular position will affect the ratio between the lever arms when these connections are not parallel. It is, therefore, desirable to adjust the brake gear so that when the brakes are applied the levers will be approximately at right angles to their connections. Accurate and symmetrical adjustment of the foundation brakes should be insisted on, as it leads to the cure of many minor defects in the gear.

The operation of this system of brake is as follows: Power being applied to the cylinder lever by the push-rod in the direction of the arrow, this lever will move in the same direction, using as a pivot the point of attachment of that connection which has the most strain upon it, until the tension on the other equals it, when it will move about a point between the two, until the brakes are fully applied, thus always equalizing the strains on the connections.

When the hand-brake at the cylinder-lever end is used, the operation is the same as described, the push-rod moving out with the lever without effect on the piston of the air cylinder. When the hand-brake at the opposite end of the car is used the cylinder lever will move about the point of connection of the push-rod as a pivot, reversing the conditions of cylinder and floating levers.

The arrangement of truck levers and connections varies with the location of the brake beams; if these are hung between the wheels the arrangement shown on the left end of Fig. 56 is used—when hung on the outside of the wheels that shown on the right is the proper one. The connections from the cylinder and floating levers are attached to the tops of the live levers *K* and *K'*, a twist in the connection bringing the clevis on the proper angle to

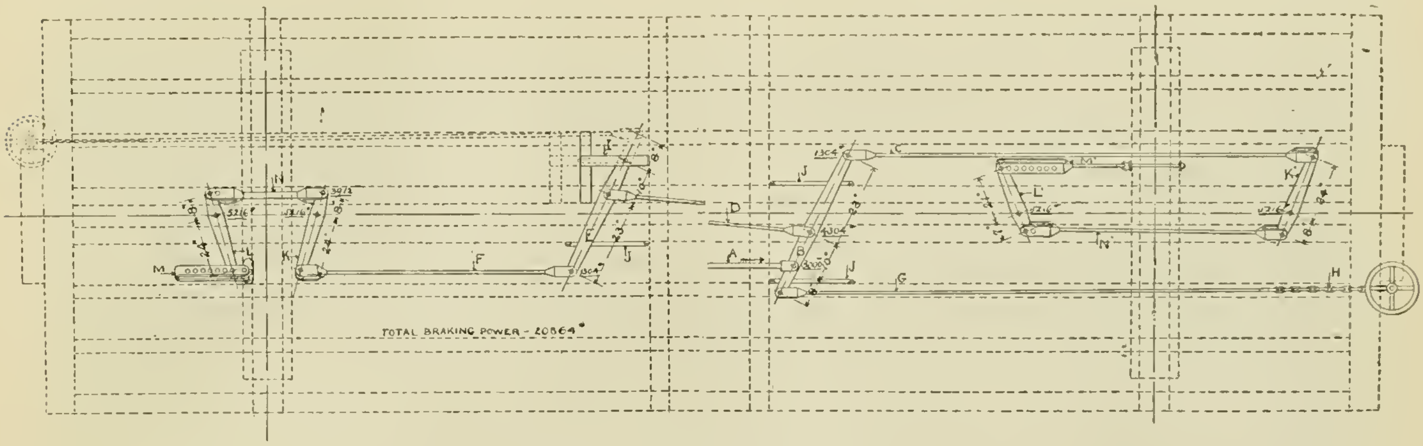


Fig. 56.—Foundation Brake Gear.

take the lever. The top of the dead levers *L* and *L'* are held in in place by the dead lever fulcrums *M* and *M'*, which are fastened in a convenient manner to some part of the truck. These fulcrums are provided with a number of holes, which allow for an adjustment of the brake shoes on the wheels to make up for the wear of the brake shoes and of the connecting pins and holes in levers and connections. The lower ends of the truck levers are connected by the truck connections *N* and *N'*, which are usually provided at one or both ends with two holes to allow for a further adjustment on account of wear. When inside-hung brakes are used this connection has a compressive strain on it, and has therefore to be made considerably heavier than the other connections, and many roads are now using a casting of malleable iron for this connection instead of making them of wrought iron. When the construction of the truck will admit the connection between the truck levers is sometimes placed above the brake beam, but this is not a very common construction. On outside-hung brakes the truck connection *N'*, as shown, is in tension.

For the sake of uniformity the sizes of the principal parts of the foundation brakes, also the general shapes of them, have been adopted as standards by the M. C. B. Association, the most important sizes being 1 inch for the thickness of the levers, 1⅛ inches for the diameter of all the holes, 1 3/32 inches for the diameter of all connecting pins, and ⅝ by 2½-inch iron to be used for the clevises. The connecting rods are usually mads ¾ inch in diameter, although the bottom truck connections are sometimes made of ⅞-inch iron, which perhaps is correct, as the strain on these is considerably more than on the others. When the brake gear is located so that the cylinder connections passes through instead of under the cross-tie timbers, the rod is sometimes cut at the center, and connected by a turnbuckle, so that a large hole need not be cut through the timber to allow the clevis to pass through.

The strains on each connection are shown in Figure 64, being based on a total pressure of 3,000 pounds on the piston, which is about the maximun obtained in an 8-inch cylinder. The figures given are calculated and levers are proportioned for a car weighting about 30,000 pounds, 70 per cent. of which distributed on the four pair of wheels would require a pressure of 5,250 on each brake beam.

The pressure which can be applied by the hand-brakes is usually not as great as that obtained with the air, but hand-brakes are not supposed to be used in coming years, except, perhaps, in switching where the speeds are slow and a light pressure is sufficient for the purpose. When it is desired to increase this pressure and the cylinder lever cannot be lengthened a sufficient amount, a pulley can be attached to the end of this lever, with a chain passing over it, one end being fastened to the brake shaft the other one to some part of the car, such as body bolster or one of the sills, by which means the power due to the length of arm of the cylinder lever would be doubled. The pull on the brake chain is usually 1,000 to 1,200 pounds with the ordinary sizes of brake shaft and hand-wheel in use. The arrangement of foundation brake shown in Fig. 64 is perhaps the simplest in use. On cars on which there are drop-doors, hoppers or other attachments on the bottom of the frame, it cannot, however, be used in just this shape and usually additional levers must be introduced to get around the obstructions. In some cases a rock-shaft, having levers at each end, is used to transmit power across the car where there is not sufficient space to allow a long lever to swing. Bell cranks can be used for changing the direction of the pull, such as would be necessary where the cylinder has to be placed at right angles to the connections. On cars with long and deep hoppers it is sometimes impossible to place the cylinder on the same level as the brake gear and vertical levers are introduced to transmit the power from one lever to the other.

(*To be continued.*)

Locomotives Recently Constructed by the Baldwin Locomotive Works.

In the accompanying group of photographs (see next page) we show a number of locomotives of various designs recently built by the Baldwin Locomotive Works, to whom we are indebted for the photographs and descriptions.

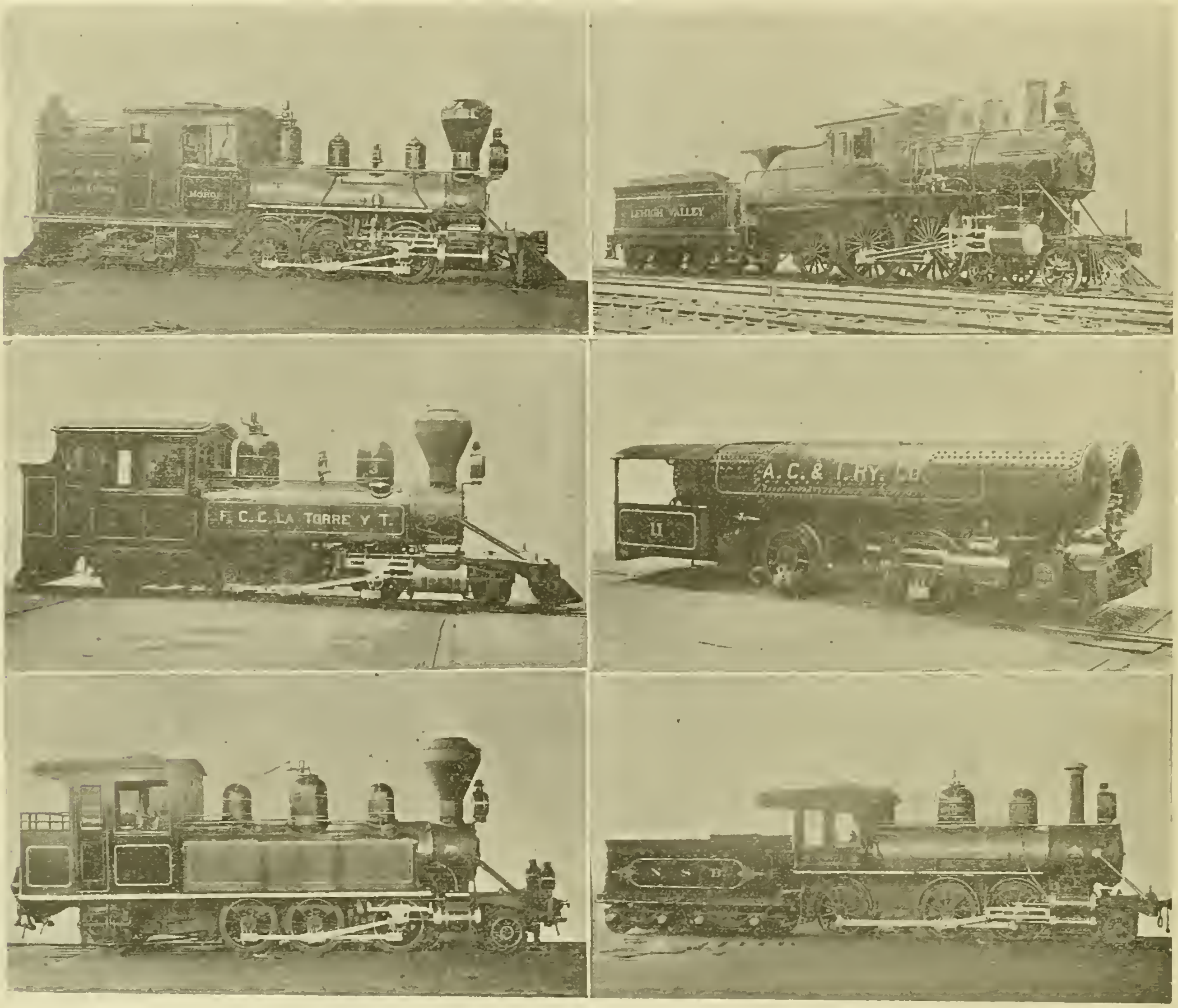
Fig. 1 is the locomotive "Moron," a double-ender, having three pair of coupled wheels and a four-wheeled rear truck, and was built for the Spanish Military Engineers, Havana. Its dimensions are:

Guge	4 feet 8½ inches
Cylinders	12 inches diameter, 18 inches stroke
Driving wheels	38 inches diameter; journals 6 inches by 7½ inches
Total wheelbase	19 feet 5 inches
Driving wheelbase	8 feet, 1 inch
Weight on drivers	45,560 pounds
Weight, total	71,960 pounds
Boiler diameter	36 inches
Tubes	94 in number; 1¾ inches diameter; 11 feet long
Firebox	38 1/16 inches long; 33⅞ inches wide; 46½ inches deep
Truck wheels	24 inches diameter; journals, 3¾ inches by 7 inches
Tank	1,600 gallons capacity

The cab of this locomotive is armor-clad, with ⅜-inch. steel plates on the sides and front, lined with ash. The doors and windows are provided with ⅜-inch steel shutters to slide over the glass panes when required, the shutters being provided with loop holes in the center to allow of firing in case of attack.

Fig. 2 is a locomotive, No. 668, of the "Atlantic" type, built for the Lehigh Valley Railroad Company. Its leading dimensions are:

Gage	4 feet 8½ inches
Cylinders	19 inches diameter by 26-inch stroke
Driving wheels	76 inches diameter; journals 8½ inches by 11 inches
Total wheelbase	24 feet
Rigid wheelbase	13 feet
Driving wheelbase	6 feet 7 inches
Weight on drivers	81,800 pounds
Weight on trailing wheels	30,050 pounds
Weight, total	140 950 pounds
Tubes	265 in number, 2 inches diameter, 15 feet 1 inch long
Firebox	114⅝ inches long, 89⅝ inches wide, 46½ inches deep
Truck wheels	36 inches diameter; journals 5½ inches by 9 inches
Trailing wheels	55 inches diameter; journals 7 inches by 12 inches
Tender tank	4,000 gallons capacity
Tender wheels	36 inches diameter; journals, 4¼ inches by 8 inches



1.—Locomotive for Spanish Military Engineers in Havana.
2.—Fast Passenger Locomotive—Lehigh Valley Road.
3.—Double-Ender for a Mexican Railroad.
4.—Compressed Air Mine Locomotive.
5.—Double-Ender for a Russian Railroad.
6.—Mogul Compound for Norwegian State Railways.

Some Locomotives Recently Built bv the Baldwin Locomotive Works.

Fig. 3 is a double-ender locomotive (No. 3), built for F. C. de Casadero a Tepetong, Mex. Its dimensions are:

Gage	2 feet
Cylinde-s	11 inches diameter by 16 inches stroke
Driving wheels	33 inches diameter; journals, 5 inches by 6 inches
Total wheelbase	19 feet 10 inches
Driving wheelbase	7 feet 6 inches
Weight on drivers	31,910 pounds
Total weight	43,410 pounds
Boiler	34 inches diameter
Tubes	62 in number, 2 inches diameter, 10 feet 11 inches long
Firebox	37 3/16 inches long, 30⅝ inches wide, 40½ inches deep
Two-wheel truck	Front and back; wheels, 22 inches diameter; journals, 3½ inches by 6 inches
Tank	550 gallons capacity, on sides of boiler

Fig. 4 is a compressed air mine locomotive, built for the Ashland Coal and Iron Company. The following are the leading dimensions:

Gage	2 feet 7¼ inches
Cylinders	9 inches diameter by 14 inches stroke
Driving wheels	28 inches diameter; journals, 4 inches by 6 inches
Total wheelbase	5 feet 3 inches
Driving wheelbase	5 feet 3 inches
Weight on drivers	20,550 pounds
Weight total	20,550 pounds
Air reservoirs	one 26½ inches diameter, 18 feet 5 inches long; one 26½ inches diameter, 15 feet 9 inches long; one 15¾ inches diameter, 13 feet 5¾ inches long

The locomotive is fitted with an auxiliary reservoir and a reducing valve. The main reservoirs carry a working pressure of 600 pounds per square inch. The limit of height is 5 feet, width 6 feet and length 19 feet.

Fig. 5 is a double-ender locomotive built for the Krotovka-Sergievsk line in Russia. Its dimensions are:

Gage of road	3 feet 3⅝ inches
Cylinders	10 inch diameter, 16 inches stroke
Driving wheels	36¼ inch diameter; journals, 4½ inches by 6 inches
Total wheelbase	19 feet 9 inches
Driving wheelbase	7 feet 6 inches
Weight, total	47,160 pounds
Weight on drivers	33,010 pounds
Boiler	34 inches diameter
Tubes, 70 in number	1¾ inches diameter, 10 feet 1 inch long
Firebox	46½ inches long, 21½ inches wide, 43 inches deep
Truck wheels	24¼ inches diameter; journals 3½ inches by 6 inches
Tank capacity	600 gallons (carried on sides of boiler)

Fig. 6 is a Mogul compound locomotive, built for the Norwegian State Railways. Its dimensions are:

Gage of road	3 feet 6 inches.
Cylinders	high pressure, 9 inches diameter by 19 inches stroke
"	low " 15 " " " 18 " "
Driving wheels	46½ inches diameter
Journals	5½ inches by 7 inches
Total wheelbase	18 feet 7 inches
Driving-wheelbase	12 feet 0 inches
Weight, total	51,844 pou ds
" on drivers	42,244 pounds
Boiler, diameter	44 inches
Tubes	157 in number, 1½ inches diameter, 8 feet 1 inch long
Firebox	52 7/16 inches long, 30¼ inches wide, 49⅛ inches deep
Truck wheels	26 inches diameter; journals, 4 inches by 6 inches
Tender, tank-capacity	1,100 gallons
" wheels	26 inches diameter; journals, 3½ inches by 6 inches

The above engine was the 15,000th locomotive built by the Baldwin Locomotive Works.

Citizenship and Technical Education.*

BY JOHN H. CONVERSE, A. B.

The debt which the citizen owes to the community for higher education involves an obligation on the part of the recipient which cannot in most cases be discharged by a pecuniary consideration. You who are alumni, or are to be alumni, of an institution like this are not privileged to use your intellectual equipment here acquired solely for your own aggrandizement. Society has claims upon you. In the practice of your profession you must contribute something to the welfare of the community as opportunity offers. The clergyman performs many offices of mercy for those in need, but who have no claim upon him. The physician, in his hospital practice and in his gratuitous attendance on the poor, renders an extensive service for which he receives no monied compensation. The lawyer, by his conduct of the cases of those unable to engage counsel discharges in some measure the obligation under which he rests. Are these learned professions, as they are called, alone amenable to this rule? There are emergencies and conditions where the mechanic, the engineer, the architect, the chemist, may render a valuable service to the community, and which he should regard as opportunities of privilege. You may not ask the architect to draw plans for your house without full compensation, but for an art gallery, or a hospital, or a library, for the benefit of society, you might well expect a concession in the regular fee. It is agreed that the happiest definition of civil engineering is that it "is the art of directing the great sources of power in nature for the use and convenience of man." If the engineer (and in that term we may include all the graduates of an institution like this) possesses a power so important, built up, as it has been, by the experience of thousands of predecessors, and made possible of acquisition by the founding of technical schools like this, he certainly has a duty to use it in some measure for the benefit of his fellows. Christianity teaches us that the Saviour of mankind promises the highest recognition of service done in His name to even the least of those in need. The relations of men in society show that there is an obligation of service even in the realm of materialistic progress.

The foregoing considerations lead to the inquiry, What scheme of education is best adapted to promote true citizenship? The true citizen must be more than a narrow specialist. His education must be thorough, comprehensive, humanizing, practical. The function of the university, properly so called, is to afford precisely such a training. It should include not only the humanities, but also, necessarily and inseparably, the preparation for a profession or calling.

The ideal university then might have, first, say, a three years' course in the humanities, leading as now to the degree of A. B.; and, secondly, a two years' course in techical, scientific, legal or other specific studies leading to the degree of C. E., M. E., E. of M., or other appropriate degree. And these two courses should be made, not optional, but obligatory, forming in effect a five years course. If it be said that students will select in preference a merely technical school where in a shorter time the desired diploma may be obtained, I answer that I have no concern with that policy. My contention is that there is room for a university wherein the training afforded and enforced shall make the citizen as well as the engineer, the broadly-cultured, self-reliant man, and not a specialist exclusively.

The trend of educational development points, I think, to something of this character as the true university. A marked change has come over the schemes of higher education during the past generation. Formerly the theory in our universities was culture for culture's sake. Utility, as an essential of the studies pursued, was little regarded, or was scouted as something common or unclean. The classics, the mathematics and metaphysics constituted in the main the approved curriculum. Complete courses in chemistry, in biology and physics were rare in the department of arts. Even the modern languages scarcely ever appeared in the curriculum. The classics were emphasized to the exclusion of the natural sciences. Some in my hearing may remember the sensation produced by Charles Francis Adams, when. two or three decades ago, in an oration delivered before the Phi Beta Kappa Society of Harvard, he denounced as a fetich the slavish worship of Latin and Greek in the college course. The feeling which he then voiced has unceasingly prevailed. Since that time the change in college methods has been remarkable. Requirements in entrance examinations have been enlarged. More Latin and Greek, and mathematics and English literature, and history are demanded as a condition of matriculation in order that more time in the four years' course may be available for the natural sciences, literature and the modern languages. In many colleges scientific courses and elective special studies struggle to replace the time-honored curriculum. Laboratory work has been introduced and enlarged; geology and biology are pursued by practical investigation; and even manual training and shop practice have found a place as cognate branches in some of our universities.

The significance of this movement is not far to seek. At a time when the ruling interests of the country were agriculture and the products of the forest and the sea, a college curriculum molded in mediæval form was sufficient. But with the development of mines and manufactures of every kind and the extension of new conditions of life, a different training was demanded. Our educational institutions have responded under the pressure of a new civilization. The founding of this institution 30 years ago was but the recognition in the mind of a sagacious business man of the demands of a new era of materialistic development. The shaping of its scope and purpose is an indication of the best form which is to be reached by what we call higher education.

In order that the general course may be covered in the term of three years, the time usually given to Greek and Latin might be considerably curtailed. In proposing such abridgement I am not insensible of the value of the study of the classics, but for the ordinary student without especial taste for the dead languages and their literature, I believe that much of the time ordinarily devoted to their study might more profitably be bestowed on other subjects. For all etymological and technical uses, one-half the time usually given to Greek and Latin in the curriculum would suffice.

It is undeniable that many boys enter college with no well-defined purpose as to their future. Neither they nor their parents know for what calling they are best adapted. A three years' general course, while giving them a broad and comprehensive culture, would better enable them to judge what profession or calling to adopt, and would bring them to an age of superior discretion, when their choice could more intelligently be made. The example and the influence of the engineering or special courses, of which by contact and contiguity they gain some knowledge, would greatly facilitate such choice. During the three years' general course the student would have constantly before him the suggestion and the purpose of acquiring a technical training, and would be less likely to be satisfied with the degree of A. B. alone.

Another advantage of the scheme. incidental, but most desirable, in my judgment, would be the opportunity for practical work which might be interjected between the general and the technical courses. At the end of the three years' general course let the student spend a year in actual business or work. Employment in the line of his future profession would be preferable, but failing that, any business experience would be beneficial. To illustrate this, take the case of an intending mechanical engineer. At the end of the three years' course the university might give and encourage a year's leave of absence, during which period the young man might find employment in a machine shop or factory and obtain some practical training in the use of tools and machinery. Much could be accomplished even in that brief time, and I venture to assert that there are many manufacturers in the United States who would heartily co-operate in such a scheme. The young man, after a year or 15 months of practical work, would enter upon the scientific studies in mechanical engineering with a higher appreciation of their value, with a more intelligent comprehension of their application, and with greater ability to assimilate the theoretical principles of the text-books. It is a well known fact that the best draughtsmen (and I use the term not for mere copyists, but for designers) are those who have had shop practice. They have learned what tools can do. and by what process results can be reached most economically and effectively. I need not extend the illustration. You will at once apply it to the case of the civil engineer, the engineer of mines, the chemist, and the architect.

The young man who has thus taken the complete course of five or six years will, when he finally receives his engineering degree, be entitled to stand as a thoroughly educated engineer. His culture will have been broad and liberal. He will be equipped for the highest citizenship, and he can stand as a peer of any in the community. There are few professions where the widest knowledge can more fully be utilized than in that of the engineer. No man, whatever his calling. can know too much. He will find use in the most unexpected manner for attainments apparently foreign to his pursuits. The engineer, of all men,

* From an address delivered to the students of Lehigh University on Founder's Day, Oct. 8, 1896.

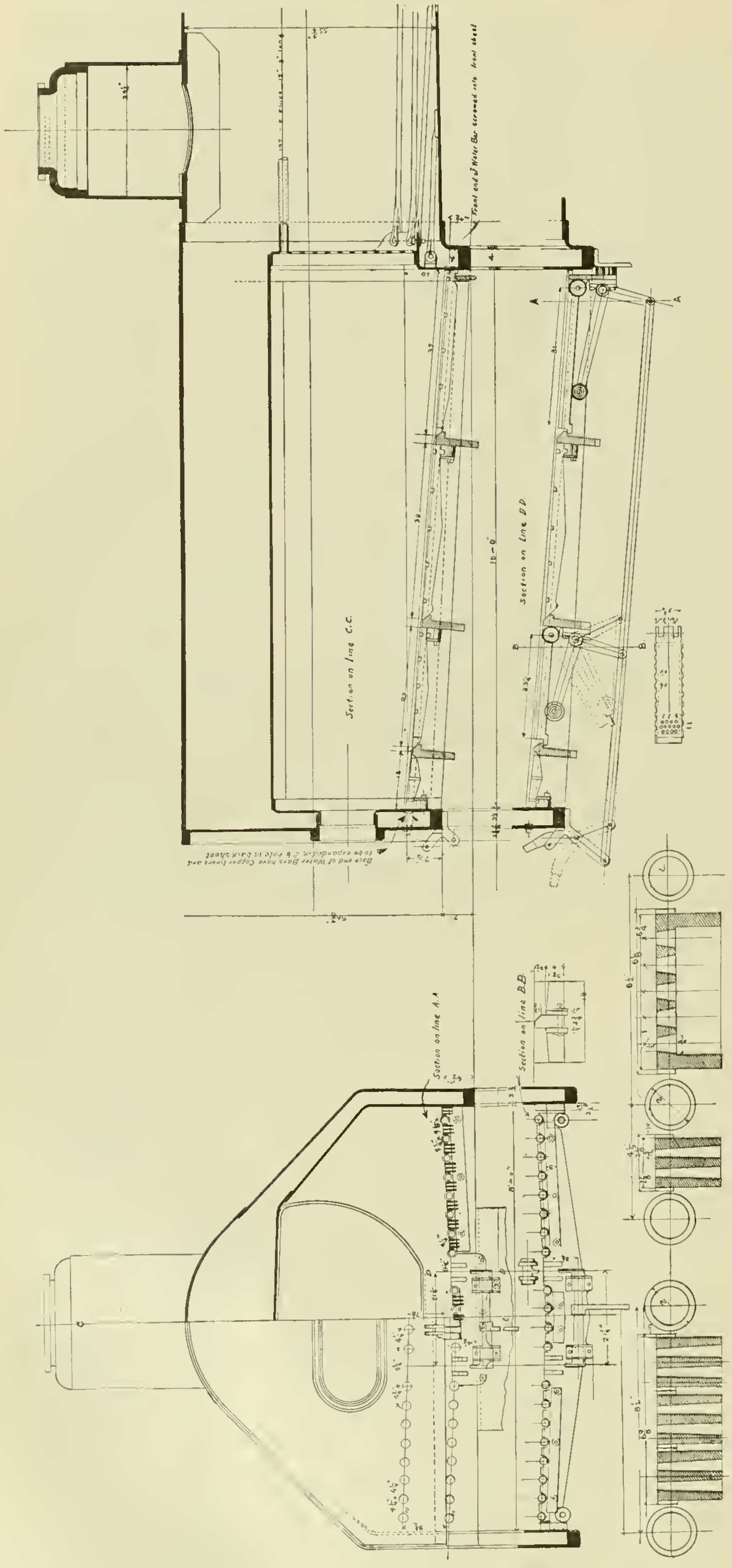


Fig. 1.—Grate for Burning Fine Anthracite Coal—Delaware, Lackawanna & Western Railroad.

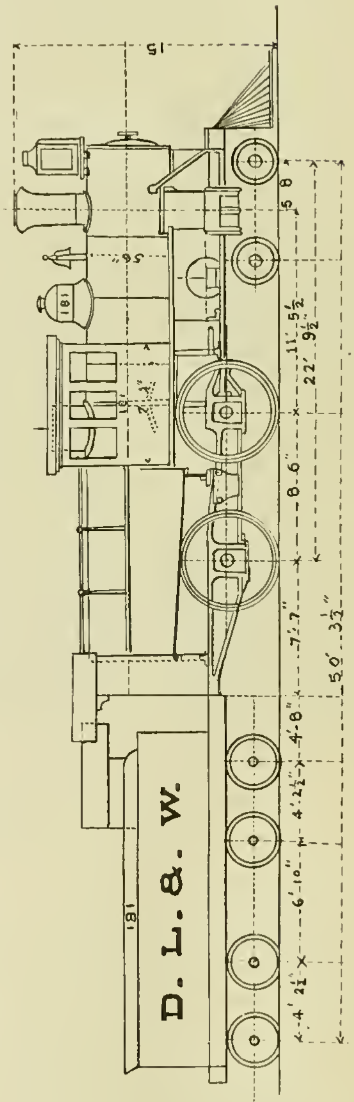


Fig. 2.—Locomotive Altered to Burn Fine Anthracite Coal.

must be a practical man, a man of business. He must be able to write concisely and vigorously. If he possesses the faculty of a public speaker, it will come in play. His knowledge of business forms and methods should be complete and exact. He should be a bookkeeper, a banker, a manufacturer, a merchant. Something at least in all these pursuits may fall to his lot in the varied conditions of his professional life. All these attainments, and more, can be utilized if he is to fulfil the definition of an engineer which I have already quoted, as one capable of "directing the great sources of power in nature for the use and convenience of man."

The young man successfully completing such a course as I have outlined has not only the liberal education which makes the man, but has also a profession or calling at his command. Uncertainty as to his future is measurably removed. He is ready to enter at once upon his life work. The contrast is marked between his case and that of the newly-graduated Bachelor of Arts of a classical or literary curriculum. The latter finds himself, not infrequently, not only with no equipment for a life work, but uncertain as to what to undertake. In many cases he is at a disadvantage compared with the boy of seventeen who has had less education but more practical experience. But the graduate of the ideal university which I have attempted te picture will be at no such disadvantage. He will be ready to take his place as a useful member of society and faithfully to discharge the duties involved in the truest citizenship.

One other advantage of such a course may be particularly emphasized. In such a five or six years' course the student will, in most cases, have before him a definite object and purpose. His studies will be pursued more intelligently and more effectively. Graduation will find him with a profession or calling enabling him at once to begin his life work. The Hebrews of old were wise in requiring every young man to learn a trade. Our educational system to-day should not prevent, but rather promote a similar policy.

In conclusion permit me to emphasize one thought. Complete as will be the education of the engineer, as the result of the system which I have outlined, it will not be all that will be required in actual business.

The education will, it is true, be an effective implement, but its owner will still have to learn its use. The interests of manufacturing and commerce have little respect for the dignity of science. Their motto is that "nothing succeeds like success." The practica man, who knows thoroughly a few things, is considered superior to the theorist, who has a practical knowledge of a variety of subjects. The graduate must, therefore, be ready to subordinate his training to the necessities of business. He will, undoubtedly, in good time, find ample opportunity to use all his acquirements ; but he must be content, in entering on his work, to accept conditions as he finds them, and to wait patiently for an opportunity to utilize his knowledge. There is one term too commonly used which is mischievous in its influence. We hear of a young man seeking a "position" in a business. It is not "position," but opportunity of usefulness that should be sought. Faithful and intelligent service will generally secure recognition in the long run. A young man of my acquaintance, who had completed his course as an electrical engineer, sought employment with the Westinghouse Electrical Company. The first work to which he was assigned consisted in trueing up by hand the plates of an armature and covering it with asbestos, a process which, perhaps, could have been as well done by an ordinary laborer. The manager grimly remarked that such a job was what they usually assigned to college graduates. The young man accepted the task without a murmur, and in no long time was promoted to more important and congenial duties. Another case within my knowledge is that of a young man who had received his degree as a mining engineer. He learned that a certain smelting works in one of the Western States had applied to the President of his insitution for some one to serve as helper in the assay department. The salary was inconsiderable, but the place was accepted, and within one year he had been promoted by successive steps until he was offered an engagement as manager of the works.

One more instance will suffice. At the commencement excercises of 1895 of my own Alma Mater, a young man, just graduated as a mechanical engineer, applied to me for employment. It was arranged, and, on Sept. 1 he reported for duty, and was assigned to work in running a shaping machine in a night gang. Several promotions were secured in a reasonable time, and, in May last, an application, which was received from the Government of the United States of Colombia for a principal instructor in a mechanical school in that country was filled by the nomination, by his employers, of the young man referred to. I have every reason to believe that he is satisfactorily and successfully discharging the duties assigned him.

As a general proposition, then, it may be said that the demand in business is for men who can accomplish specific results. Any opportunity of service, if in the right direction and patiently and faithfully utilized, has in it the promise of a successful and useful career. Add the broad, complete and symmetrical training which it is the function of the university to give, and the result may be not only individual prosperity, but true citizenship.

Grate for Burning Fine Anthracite Coal.—Delaware, Lackawanna & Western Railroad.

On the main line of the Delaware, Lackawanna & Western Railroad most of the engines have been burning hard coal costing $2 per ton. The coal was of the size usually burned on locomotives and the grates did not differ materially from those used elsewhere for hard coal. The company can obtain fine anthracite for 70 cents per ton, and it is clean and of as good a quality as the larger coal. Its use results in such a large saving in the fuel bills that all engines are being adapted for burning it as fast as the opportunity offers to make the change in the boilers. Mr. David Brown, Master Mechanic at Scranton, has designed the grate shown herewith for burning this fine coal and it has given excellent results. The fine coal requires a large grate area and the openings in the grate bars and between them must be small to prevent much of the coal from falling through.

From the illustrations shown herewith it will be seen that the grate is a combination of water tubes and cast-iron grate bars. For 19-inch cylinder engines the grate is of the dimensions given; that is, 10 feet long by 8 feet wide, or an area of 80 square feet. There are 20 water tubes, each 2 inches outside diameter. These are screwed into the tube sheet and expanded into the back sheet, a copper ferrule being used at the back and to make the joint tight. These tubes are spaced 4¼ inches apart from center to center, except that the second space on each side of the center line of the boiler is 8½ inches. This is for the purpose of providing dumping grate bars at these places. There are three cross-bearers, on which the grate bars rest, and at the front and back ends of the box additional bearers are attached to the sheets. The fixed cast-iron grate bars rest on these bearers and almost completely fill the space between the water tubes. The bars are only 1⅞ inches wide, except at the ends, where they are 2⅛ inches. Their openings are only $_1$ inch wide. Where the tubes are 8½ inches center three bars of the same pattern exactly fill the space. At the sides of the box the bars that fill the spaces between the outermost tubes and the sheets have no openings, a wise provision, as it keeps the cold air from coming in contact with the sheets.

The dumping grate bars, as already stated, are placed in the two wide spaces between the water tubes. Two of them extend from the front tube sheet to the first cross-bearer, and another pair extend from the second to the third cross-bearer. These are operated in pairs from the foot plate by the connections shown. By means of these dumping bars the fire is easily cleaned.

The engines requiring new boilers are all being provided with the large grates, and as they burn about the same amount of fine as of large coal, the cost of the fuel is reduced by the change in the ratio of $2 to 70 cents, or to about 35 per cent. of what it was.

Fig. 2 shows in outline a 19½ by 24-inch, eight-wheeled engine altered for burning the fine coal. It formerly had a firebox on top of the frames, which explains the shape of the latter. The engines of this class are doing excellent work, and as a matter of possible interest to our readers we append the following dimensions:

Cylinders	19½ inches by 21 inches
" steam ports	1½ inches by 17¼ inches
" exhaust "	3 inches by 17¼ inches
" bridges	1⅛ inches
Slide valves	Allen-Richardson balanced
" " travel	5 inches
" " outside lap	⅞ inches
" " inside "	line and line
Boiler, diameter of front course, inside	56 inches
Flues	218, 2 inches diameter, 12 feet 10 inches long
" heating surface of	1,451 square feet
Boiler, center to rail	8 feet 5 inches
Firebox	8 feet wide, 10 feet long
" grate area	80 square feet
" heating surface	140 square feet
Total heating surface of boiler	1,591 square feet
Weight of engine on drivers (loaded)	84,400 pounds
" " " " truck	34,100 pounds
" " " " total	118,500 pounds
Tank, water capacity	3,700 gallons
" coal "	7 tons
Boiler pressure	161 pounds per square inch

The Explosive Properties of Acetylene.

Some experiments recently completed by Messrs. Berthelot and Vieille show that considerable precautions are necessary in dealing with acetylene, particularly in the compressed state. The gas in question is an endothermic body, that is to say, a quantity of heat is liberated on decomposing it into its constituents, hydrogen and carbon. Reasoning on this basis, the experimenters determined to try whether the gas could not be detonated by means of a cap of fulminate of mercury. This proved possible, though at atmospheric pressures the explosive wave did not proceed throughout the body of the gas, the decomposition being limited to the immediate neighborhood of the detonation. When, however, the gas was compressed, the experiments showed that it might prove a dangerous explosive. In fact, it was not then necessary to use a detonator, as it was found that the mere heating of the gas by an incandescent platinum wire was sufficient to cause an explosive decomposition of the acetylene. Average figures from a number of experiments made with different degrees of initial compression showed the following rises of pressure:

Initial pressure. Pounds per square inch.	Maximum Pressure observed on explosion. Pounds per square inch.	Ratio.
31.7	138.7	4.4
49.4	271.0	5.5
85.1	600.0	7.0
160.0	1,312.0	8.2
1101.0	13.028.0	10.1

On opening the steel test tube after an experiment, it was found to be filled with a mass of finely divided carbon agglomerared together by the increase of pressure. The rise of temperature at the moment of explosion was considerable, and in the case of the last of the experiments, referred to above, amounted to as much as 2,750 degrees centigrade. It was, moreover, found possible to detonate liquefied acetylene in the same way, a pressure of over 35 tons per square inch being then attained. The explosion was started, as in the previous cases, by means of a white-hot platinum wire. Dropping a bottle of the liquefied gas, or allowing a heavy tup to fall on it, proved insufficient to detonate the mixture, although when the bottle was broken by the tup a violent explosion occurred. This however, arose from the combustion of the gas, and thus differed materially in nature from the experiments previously made, in which the acetylene was merely resolved into its elements.—*Engineering.*

Corrosion of Metal Tender Frames.

In a discussion on the preservation of metal frames for tenders and cars, before the Western Railway Club, Mr. E. M. Herr said in part:

"On the Chicago & Northwestern road we have a large number of all metal underframes on tenders which have now been in service from eight to twenty years. In general the service of these underframes has been wood up to this time, and they have given but little trouble. These metal frames are now rusting away, and though none have yet corroded so much as to require renewal, the last few years' experience indicates that the amount of corrosion is increasing in an advancing ratio which will soon make extensive repairs necessary, if, indeed, entire renewal does not have to take place. This corrosion is not uniform. Those in service a long time are often not more corroded than those in service not so long. This is no doubt due to a different kind of usage and difference in the kinds of water, as, indeed, the leakage from the tank has a great deal to do with the corrosion. The following table gives the principal data in regard to these sills:

Kind of Engine.	Cylinders.	Year built.	Cap. of tank.	Max. Corrosion on iron sills.	Min. Corrosion on iron sills.	Aver. Corrosion on iron sills.
				Per cent.	Per cent.	Per cent.
8-wh. road.......	16×24	1879	2,350	10.7	4.5	7.0
" "	16×24	1880	2,000	15 0	1.5	8.8
" "	16×21	1888	3,000	11.2	5.7	7.8
6-wh. sw'ch'r....	17×24	1888	2,300	11.2	6.7	9.0

"I will sum it up in saying that the maximum amount of corrosion found in the sills of these tenders which have been in service two of them 16 or 17 years, the other two 8 or 9 years, amounts to from $10\frac{7}{10}$ to 15 per cent. per section. The minimum amount of corrosion varies from $1\frac{1}{2}$ to $6\frac{8}{10}$ per cent., the average being from 7 to 9 per cent. This shows that the tender frames 8 and 9 years old are rusted worse in some cases than those 16 and 17 years in service."

Mr. Herr then referred to the investigation on the Eastern Railway of France, published in the August number of this journal, in which one conclusion arrived at was the desirability of painting metal frames once in three years, and states that his road has decided to treat their tender frames in the same way. He thought the paint could be sprayed on by compressed air.

Electricity as Applied to Traction.

At the opening meeting of the twenty-third session of the Liverpool Engineering Society, the President-elect, Mr. S. B. Cottrell, delivered, before a full audience of members and their friends, his inaugural address.

He said he proposed to follow what had usually been the custom on these occasions, viz., to deal with the particular aspect of en-engineering with which he was himself directly interested—the development of railways. The President referred, in the first place, to the rapid expansion of railway enterprise, pointing out that while not more than 67 years had elapsed since the completion of the Liverpool & Manchester Railway, there were now open in various parts of the world upward of 400,000 miles of railway. He showed that as soon as steam power was applied to manufactures in this country railways became a necessity. Their introduction developed our coalfields, and their expansion in various parts of the world had greatly increased employment for shipping and stimulated steam navigation. After sketching the general expansion of railways, Mr. Cottrell came to the main point of his address—Electricity as applied to traction. The first great step forward in this direction was made in 1867, when Dr. Werner Siemens described to the Berlin Academy his discovery of a self-exciting dynamo, a discovery soon followed by the transmission of power from one dynamo to another. Electro-motive power, however, began in earnest with the opening of the first electric railway in Berlin in 1879. The subsequent growth of electric rails and tramways in this country, on the Continent, and in the United States and Canada, where 90 per cent. of the street railways are worked by electro-motive power, was the subject of an interesting reference. In this direction he pointed out the special value of electric traction for the purpose of inter-communication in cities, mentioning the particular instance of London, whose worst deficiencies in this respect were about to be remedied by new underground electric railways now authorized or in course of construction. By the application of electricity, the notorious discomforts of the London Underground would doubtless before long become a mere record. Discussing the application of electricity to main lines of railway, Mr. Cottrell was of opinion that the application would mean a different class of electric traction to that now employed. The present system of 500 volts continuous current had to be limited to a distance within 12 miles with any degree of economy, but by doubling the present working voltage the cost of transmission would be enormously lightened. A 1,000 volt current would not be impracticable under proper conditions as to safety. It would reduce the cost of conductors to one-fourth the present amount, and the problem would be enormously simplified by operating roads 30 or 40 miles in length from a single power station, while these stations, if placed where coal and water were abundant and worked by latest labor-saving appliances, would reduce the cost of output to a minimum, and enable power to be economically transmitted at high voltage to transferring substations on branch lines up to 150 miles away. If the suggested speed of 100 to 120 miles an hour was ever to be attained, it would be by the electric locomotive. There was practically no limit to the rotary motion of an electric motor, while, unlike the steam locomotive where the speed was increased by increasing the size of the driving wheels, and thus reducing the tractive power, the wheels might be of small diameter, which reduced the wheel base and gave the highest efficiency of tractive power. The Heilman locomotive made a great stride in advancing electric traction, since it did not involve the use of power stations. This locomotive generated its own electricity, which was conveyed to motors fixed on the wheels. The whole weight of the locomotive was utilized for tractive purposes, and was unlike the steam locomotive in this respect, since in the latter only a small part of the weight was so made use of. Another advance was Tesla's discovery of the rotating magnetic field and the construction of a motor which dispensed with commutators and brushes, always a source of trouble and expense. These improvements pointed to others, and showed that the record of railway development, one of the most interesting chapters of practical science, was far from closed.

New Publications.

ONE THOUSAND POINTERS FOR MACHINISTS AND ENGINEERS. By By Chas. McShane. Griffin & Winters, Chicago. 326 pp., 5¼ inches by 7½ inches.

This is a second edition of a book of the "practical" type, and intended for engineers, firemen and mechanics. There is one fact which has always been puzzling. Why is it that authors of this kind of literature seem to think that the omission of definite and and indefinite articles, and other minor words, makes what they write appear more practical? As an example the directions which are given for lining up guides may be taken. These are represented in the following extract, with the omitted words in italics and parentheses.

"Measure *(the)* distance from *(the)* top of *(the)* cross-head to *(the)* center of *(the)* cross-head. Line *(the)* cylinder. Set *(the)* top guide first *(at the)* right distance from *(the)* line, use a square on *(the)* side and keep *(it)* perfectly central with *(the)* line and level with *(the)* frames. Caliper *(the)* head and set *(the)* bottom guides *(at the)* right distance from *(the)* top guide and perfectly central with *(the)* top guide. Slip in your gib and line *(it)* up close, then put up *(the)* head."

The whole book is written in this kind of railroad English, apparently with the idea that it gives to the language a sort of air of practicality. To paraphrase the language attributed to Mr. Lincoln, "if practical men like this sort of writing, then this is the kind of book which will suit them." The fact is, though, that the omission of the minor words often makes the writing indefinite, as for example when the author says, "use a square on side and keep perfectly central," it is not apparent what is to be kept central. We have inserted the word "it" on the assumption that he means the square should be kept central, but that is not certain.

The purpose of the book, the author says, is to give instruction in the "modern methods of performing work in the various branches of our trade, locomotive construction being the special feature." The discussion of the various subjects treated is a kind of combined explanation of the construction, operation, erection and repair of the different parts of locomotives. While these contain a great many very useful directions and hints to practical men, the general defect of the treatment of the subject is that they lack comprehensiveness. But it may seem to be invidious to find fault with a plate of very excellent hash by saying that it does not include soup, fish, a roast, an entree and a dessert. Good hash is excellent and very nourishing food, and has great capacity for "staying by you." Now, metaphorically, the book before us has all these characteristics. It is full of useful information and mental nourishment, and any practical or theoretical person who will study it will find that the information it contains will "stay by him" as long as life lasts.

It begins with a brief history of the locomotive and treats of the following subjects: Slide valves, link motion, steam indicators, locomotive-testing plant, cylinders, wheels and axles, shoes and wedges, rods and brasses, guides, cross-heads, etc., steam chests, pistons, rods, packings, etc., exhaust nozzles, steam pipes, etc., lathe work, metric system, injectors and checks, lubricators, steam and air gages, compressed air, locating blows and pounds, breakdowns, accidents with compound engines, Lewis valve gear, modern locomotives, fast runs, air-brake and improved tools.

The discussions of those subjects are more of the nature of practical directions how to do what requires to be done than of theoretical elucidation of them. The section relating to counterbalancing may be taken as an illustration. In explanation of the theory of it it is said:

"Reason will teach you that there is no such thing as having an engine counterbalanced perfectly at all times, for the simple reason that steam is the power, and if balanced perfectly when using steam it will not be perfect when the steam is shut off, as the steam carries the piston-head, cross-head, etc. The object is to balance the wheels as near as possible, when running, and overcome a part of the strain in the pin when shut off. But to counterbalance the parts approximately correct, so that excessive strain will not be imposed, is quite possible; care must be exercised to avoid too heavy a counterbalance, as it would give an excessive rail pressure."

Now, it would require a somewhat full dissertation in the subject of counterbalancing to show the inadequacy of the explanation of the theory, and for this there is not time now nor room here. After the explanation quoted full and specific directions are given—excepting that most of the definite articles are omitted—for arranging, proportioning and putting the counterbalances in the wheels of a locomotive. Most of the other subjects are treated in a similar way. The practical shop man will find the instructions are usually very clear, and that they will be very useful. A good index adds to the merits of the book.

A MANUAL OF STEAM BOILERS, THEIR DESIGN, CONSTRUCTION AND OPERATION. By R. H. Thurston, Dr. Eng'g, Director of Sibley College, Cornell University. New York: John Wiley & Sons. 881 pp. 5¾ inches by 9⅛ inches.

There are books which are calculated to produce a feeling of dismay in the mind of a reviewer when he takes them up to summarize their contents and estimate their merits in the few paragraphs which can usually be devoted to them in a notice of this kind. The book before us is one of this kind. Its size, the wide range of subjects treated, the distinguished reputation of the author and the extended field of his experience and knowledge, from which he has been able to garner its contents, incline a reviewer to hold his opinion in abeyance rather than to express it with much confidence. A review of such a book in the time and space which is available must of necessity have very much of an "impressionist" character and cannot be an adequate analysis of its contents, and mere enumeratinn of the heads of the chapters will indicate how impossible it would be to say more in a notice of this kind than merely to express an opinion of the scope and purpose of the book. The general subjects of the different chapters are as follows: History; Materials; Fuels and Combustion; Heat; Thermodynamics; Steam; Design; Accessories—setting and chimneys; Construction; Specifications; Operation and Care; Efficiencies; Trials; Explosions; Appendix.

The first observation which is suggested is that the book is too big. In these busy times, how many engineers can be found who have the time to wade through nearly 900 pages unless they contain matter of pre-eminent importance. Instead of this being so in the present instance, in many places the writing seems to be unnecessarily prolix. Take as an example the following paragraph:

"Safety in operation is one of the most essential requirements which the designer, constructor and user of steam boilers must be prepared to fulfill. As will be seen later, the quantity of stored heat-energy in the steam boiler is usually enormous, and this energy is stored under such conditions that, if set free by the rupture of the containing vessel widespread disaster may ensue."

It is said in the preface that the book is intended for engineers and a text-book in schools of engineering. Can it be possible that there are any persons in either of these two classes who will read such observations with either profit or interest? Would it occur to anyone worthy of being called an engineer or a student in a school of engineering to think that "safety in operation" *was not* "one of the most essential requirements" in boiler construction? Can it be that any person in either of those two classes is ignorant of the fact that "the quantity of stored heat-energy in the steam-boiler is usually enormous," or that it "is stored under such conditions that if set free by the rupture of the containing vessel, widespread disaster may ensue"? Or again, the chapter on Materials opens with the observation that "the quality of the materials used in the construction of steam-boilers must obviously be very carefully considered" (who thinks otherwise?) "Not only is the steam-boiler expected to bear great strains and high pressure, but the terrible consequences which are liable to follow its rupture makes it important that it should sustain its load and do its work with the most absolue safety." Who doubts it? What is the use of loading down what is intended to be "a fairly complete, systematic and scientific, yet 'practical' manual on the steam boiler, its design, construction and operation," with such commonplace remarks?

Or take still another illustration. On page 42 it is said: "Problems in steam-boiler design and construction are among the most interesting, as well as important, which arise in the practice of the engineer. These problems may and usually do take many distinct forms." Or, again, the reader is told that "the general method of solution of problems in design is to study the case very carefully in the light of all information that can be gained relating to the special conditions affecting it, and then by comparison of the results of experience with various boilers under as nearly as may be similar conditions determining the best form for the case in hand." All this is very, very obvious. Why should a book intended for full-grown engineers be loaded down with such trite observations?

Some fault may also be justly found with many of the engravings. Most of them are "process" reproductions from other engravings for which no credit is given. Some of these on pages 24, 25, 30, 32, 34, 36, 40, 148, 378, 379, 392, 396, 406 and 419 are wretchedly bad. The author and the publisher of the book would both consider it very "bad form" to appear in public with a soiled collar or shirt-bosom, but they have issued this publication with engravings which are smudged to an extent which makes them not only unsightly but incomprehensible. A collar is worn only for a day or an evening, but the illustrations of a book like this are to be presented to the public through a whole life-time or longer, and are intended to serve a much more important purpose than any merely persona habiliments ever do.

In announcing that his book "is the outcome of an attempt to meet a demand for a fairly complete, systematic and scientific, yet 'practical' manual," an author assumes the responsibility of his own reputation. In the present instance such an announcement may fairly lead the reader to expect that such an attempt would result in a treatise which would somewhat comprehensively summarize the most important existing knowledge relating to the subject, or, in other words, that it would give a fair presentation of the "state of the art" of boiler-making up to date. Judged by this standard the book is disappointing, and is not what the reputation of its distinguished author would lead the reader to expect. The chapters on the design and construction are neither "complete, systematic, scientific," nor "practical," and, considering their importance, the treatment of these subjects is entirely inadequate for a treatise such as the one before us purports to be.

The best chapter, perhaps, is that on boiler trials, and even in that the reader must feel inclined to resent being told that in making such trials "the engineer conducting the experiments is expected to ascertain all the facts which go to determine the performance of the boiler, and to state them with accuracy, conciseness and completeness. In the attempt to ascertain these facts the engineer meets with some difficulties, and finds it necessary to exercise the utmost care and skill." Really! Some of the illustrations of the chapter on boiler explosions would be unworthy of an illustrated Sunday sensational daily or "penny dreadful." What is valuable in the book could be condensed into a half or a third of the space, and in that form would be much more useful than it now is. Those who know the admirable work which Professor Thurston is capable of and has done must feel that he has hardly done himself—or his readers—justice in the book before us.

Books Received.

Catalogue of the Michigan Mining School, with Statements Concerning the Institution and its Courses of Instruction for 1896–1898. Houghton, Mich. 1896.

Catalogue of the University of Illinois, 1895–96. Urbana, Ill.

Commissioner's Report on the Queensland Railways for the Year Ending June 30, 1896. Brisbane, Queensland, Australia, 1896. 66 pages. 8 inches by 13 inches.

Tenth Annual Report of the Commissioner of Labor. Volume II., 1894. Strikes and Lockouts. Government Printing Office, Washington, D. C.

Special Consular Reports. Money and Prices in Foreign Countries, being a series of reports upon the currency systems of various nations in their relaton to prices of commodities and wages of labor. Volume XIII., Part I. Bureau of Statistics, Department of State, Washington, D. C. 1896.

Cost of Repairs to Electric Street Cars.

In an article on "Car Trains vs. Double-Truck Cars," the *Street Railway Journal* makes a comparison between the repair expenses of short and long street cars. The long cars are mounted on two four-wheeled trucks, and have bodies 26 feet long with 18 cross-seats, giving a seating capacity of 36 in summer and 34 in winter, when the stoves are in use. The cars weigh 23,500 pounds each, and there are 44 of them in the service from wihch the data is collected.

The short cars are only 20 feet long over the body, are carried on four wheels and weigh 16,000 pounds. They seat 28 persons in summer and 27 in winter. They haul trailers when traffic is heavy, and these trailers weigh 5,000 pounds, and seat from 19 to 35 persons.

The cost of repairs to these cars are given in the accompanying table. The motors for the long cars are G. E. 800 and for the short cars W. P. 50.

	No. of cars.	Average seats per train.	Motor repairs.				Truck repairs.				Total motor and truck repairs per car per day.
			Total for first six months of 1896.	Per car per year.	Per seat per year.	Per car per day.	Total for first six months of 1896.	Per car per year.	Per seat per year.	Per car per day.	
Long car.	44	35	$6,681.43	$303.70	$8.66	$0.83	$5,328.58	$242.21	$6.93	$0.66	$1.49
Short car.	74	35	7,304.04	189.74	5.42	0.52	4,274.59	111.02	3.18	0.30	0.82

From this table it will be seen that the total repairs to a long car per year is $545.91, and for the short car the figures are $300.76. For a comparison it would be necessary to go into many other items besides repairs (and this has been done in the article referred to), but to our readers the interesting point is that the expense for repairs should be as great as they are shown to be in the table we have copied.

Trials of the Pneumatic Machinery on the U. S. Monitor "Terror."

The monitor *Terror*, of the United States Navy, is a vessel that has attracted considerable attention from naval experts because of the pneumatic machinery installed on board of her. Compressed air is used to operate the gun turrets, elevate and depress the guns, hoist the ammunition, take the recoil of the guns and to steer the ship. About the middle of last month the vessel left her anchorage off Staten Island and steamed out to sea to give her guns and the pneumatic apparatus a full trial. From the account of the first day's trial, as it appeared in the New York *Sun* of Nov. 20, we take the following:

The monitor *Terror*, of the United States navy, did to-day what no other ship in the United States navy ever did. She fired solid shot at sea from her four 10-inch guns in one volley. All the guns went off as one piece. They were fired by electricity from the bridge. Nearly 1,000 pounds of powder was burned in doing it and a ton of metal was hurled into the deep. That volley represented about $500 worth of material destroyed. The recoil of the four guns represented no less than 56,000 foot-tons, and yet the *Terror* showed scarcely a tremor as the guns plunged back from the discharge and then slid into their places.

Eight years ago Secretary Whitney of the Navy Department signed a contract with the Pneumatic Gun Carriage and Power Company, of Washington, to supply a pneumatic system of steering and of operating the machinery turrets in the *Terror*. No vessel in the world had ever made use of a pneumatic system in steering or in operating turrets, and Secretary Whitney's contract was a good deal of an experiment. It was not until yesterday and to-day that any test was made of the system. The Terror is still the only vessel in the world so equipped, and upon the result of this test may depend important changes in handling big guns on warships and in steering all kinds of large vessels. The trial was not fully completed, but so far as it went it was a complete success for the pneumatic system.

It is because of the fact that the *Terror* may mark another distinct advance in naval affairs by Americans that this trial trip was of unusual significance. On April 15 last the vessel went into commission. She went out cruising for two weeks in August and it was found that, so far as steering went, the pneumatic system, whether operated directly by wheels or by levers under electric control, was successful. It was also found that in turning the turrets, elevating or depressing the guns, hoisting the ammunition, loading the guns and receiving the terrific recoil after their discherge, the system was effective and superior to the use of steam or hydraulic power. The air-compressors (made by the Norwalk Iron Works Company) get up a working pressure in from two to three seconds. There is no reservoir for the compressed air except the large 8-inch pipe which runs through the ship. In this pipe a pressure of 125 pounds to the square inch is generated in 45 seconds. A small pipe leads some of this air to the steering-room. It passes into cylinders on either side of the rudderhead. A man turns a wheel in the chart-room, turret or steering room with a pressure of one finger and from one of these cylinders a big piston rod emerges and pushes the rudderhead as far as the man at the wheel desires. There is no rattle of chains, no leakage of pipes, no overheated room. When the man at the wheel wishes to throw the rudder the other way the piston from the other side darts out and the rudder goes over. A small lever can be attached to an electric motor (controlling the air-valves) and by swinging this lever back and forth the rudder goes over as as easily as if a massive steam engine had done it all.

This rudder was turned to-day from hard-a-port to hard-a-starooard in the short time of six seconds. That was unheard-of speed. Remarkable time was also made in turning the monster turrets. All the air was exhausted from the compressors and the machine was started. In less than three seconds a turret weighing more than 250 tons was swinging in its circle. The compressor generated its full force of 125 pounds pressure in the short time of 45 seconds. There was no vibration to be felt in the turret, and the monster guns showed not the slightest tremor as they swung around. The turrets were turned by a simple turning engine, and the men who worked in them were not clad in oilskins, as in most turrets, but swung merrily to their work half stripped. A test was made of moving both turrets, elevating the guns and swinging the rudder by means of one compressor. In 52 seconds both turrets were completely swung around.

The speed simply astonished all the naval officers. The Trial Board consisted of these officers: Capt. P. F. Harrington, of the

Terror; Naval Constructor F. L. Fernald and Chief Engineer George W. Stivers, with Lieut. Albert Gleaves as recorder. The time allowance for swinging the helm clear over was 16 seconds The time allowance for turning the turrets was also beaten by as large a proportion as the manœuvers with the helm.

The great test of the day was the volley firing from the 10-inch guns. This, too, was to be a time test. Five volleys were to be fired from them at intervals of not less than three minutes. The guns were to be loaded completely, without any previous preparation of ammunition. The crew had practically no drill in the work. It was found that the first gun in the after turret was loaded in 1 minute and 37 seconds. The first gun in the forward turret was loaded in 1 minute and 46 seconds. The second gun in the after turret was ready for firing in 2 minutes and 9 seconds, and the second gun in the forward turret was ready 22 seconds later. Thus all four guns were loaded inside of 2 minutes and 31 seconds. As soon as the guns were ready the signal to fire was given by a member of the Trial Board. Navigating Officer Curtis stooped over his electric battery, turned a handle swiftly, and at once the ship shook under the mighty reverberation of the four guns.

As we go to press word comes that the vessel's tests at sea have been completed and are eminently satisfactory.

Arbitration Committee Decisions.

In addition to the four] items already passed upon by the Arbitration Committee for the guidance of roads during the year, and reported by us last month, the following subjects were brought to its attention at its meeting held Nov. 6, 1896, by correspondence from the members of the Association, and were considered worthy of a ruling in accordance with the instructions from the Association that the committee should make a ruling on questions arising and not settled by the rules, which ruling should stand as a part of the rules for the year :

E. When airbrake hose is missing it is evidence of unfair usage, and the cost of replacement is chargeable to the party having possession of the car.

F. There seems to be some misunderstanding also in regard to Section 49 of Rule 3, Section 15 and 16 of Rule 4 and Section 5 of Rule 5. The Arbitration Committee rules that a proper understanding is as follows :

It is the intent of the rules that a repair card shoule be used in all cases when repairs are made, whether such repairs are made right or wrong, or whether they care to be charged to the car owner or not.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued from page* 313.)

This increase of the co-efficients is graphically shown in Fig. 75. The abscissas of both diagrams give the grate areas in square feet, while the ordinates give the values of the corresponding sectional co-efficients. The co-efficients were calculated and the diagrams drawn to express an average for large and small grate areas and for different locomotives with varying ratios. It has been found that the ordinates of the connecting line for both forms of stack lie in a straight line, from which it follows :

With an increasing grate area the sectional co-efficient increases in an arithmetical ratio.

Referring to the throwing of sparks, it may be remarked that I found this to be no greater with the experimental stack as applied to the four-coupled Erfurt locomotive than in the case of the four-coupled express passenger compound locomotive. We can thus apply a spark arrester with this stack with the same certainty of safety that we feel in connection with the compound locomotive.

The two lines of the diagram in Fig. 75 are not parallel to each other, but that of the cylindrical stack rises more abruptly than the other, and this in such a ratio that for the same abscissas the value of its ordinates is about one and a half times as much as that of the conical stack. Thus we obtain for the same ratio

The section of a cylindrical stack is $1\frac{1}{2}$ times as large as that of the waist of an equivalent conical stack with a flare of $\frac{1}{6}$.

Or the diameter of the cylindrical stack is equal to $\sqrt{1.5} = 1.2247$ times the waist diameter of a conical stack with a flare of $\frac{1}{6}$.

In consequence of the changeability of the co-efficients it is evident that an accurate calculation can only be made by basing it upon the sectional area of the tubes.

The value of the co-efficients can, to be sure, be taken from the lines of the diagram given in Fig. 75, but, in order to give an exact

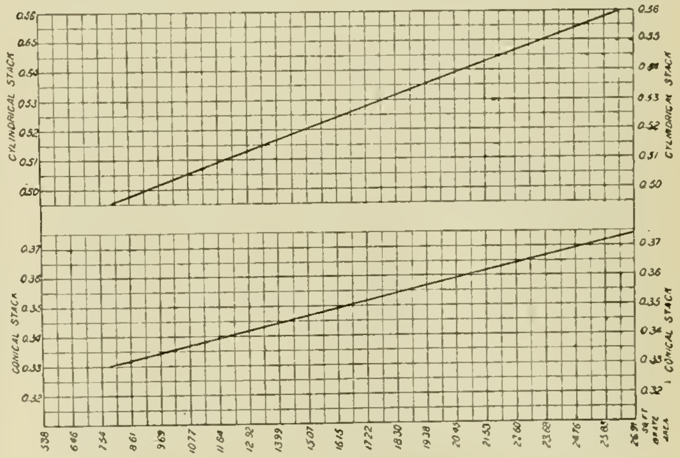


Fig. 75.

reading of the same, Table XXVIII. is appended. It gives the value of this co-efficient for 15 different limits of grate area within the limits of 9.68 square feet and 25.29 square ft. In it *fs.* cyl. = the sectional area of the cylindrical stack, *fs.* con. = the sectional area of the conical stock, contracted on a flare of $\frac{1}{6}$ at the waist.

TABLE XXVIII.

Grate area.	Sectional coefficient φ of	
Square feet.	*f s* con.	*f s* cyl.
9.68 to 10.22	.3350	.50250
10.76 to 11.30	.3375	.50625
11.84 to 12.38	.3400	.51000
12.92 to 13.46	.3425	.51375
14.00 to 14.54	.3459	.51750
15.07 to 15.61	.3475	.52125
16.15 to 16.69	.3500	.52500
17.23 to 17.77	.3525	.52875
18.30 to 18.84	.3550	.53250
19.38 to 19.92	.3575	.53625
20.45 to 20.99	.3600	.54000
21.53 to 22.07	.3625	.54375
22.61 to 23.15	.3650	.54750
23 68 to 24.22	.3675	.55125
24.76 to 25.30	.3700	.55500

If fr indicates the sectional area of the tubes in square feet, the sectional area of the stack in square feet will be represented by

I. $$fs = \varphi\, fr$$

The diameter S of the nozzle opening can be obtained from the sectional area of the tubes by means of the formula

IIa. $$fb = \tfrac{1}{25} fr = 0.04\, fr$$

when fb indicates the sectional area of the nozzle.

A simpler method still leads one to the same result, if we calculate it directly from the diameter of the stack.

The equation referred to becomes

IIb. $$S = \tfrac{1}{3} d$$

in which d represents the diameter of the waist of stack having a flare of $\frac{1}{6}$.

The nozzle distance x is calculated as we have indicated in section III., by the formula:

$$x = (1\tfrac{1}{2} \text{ to } 1\tfrac{3}{4})d$$

for which we take the smaller value

III. $$x = 1\tfrac{1}{2}d$$

This gives, empirically, a satisfactory position.

Since it is possible to take x as equal to $1\frac{1}{2}d$, the value obtained from III. can, in cases of necessity, be increased a few inches in round numbers.

How great, now, should we make the total height H ?

In section III. it was roughly shown from the experiments with the experimental apparatus that a satisfactory construction can be obtained by making H from $4\frac{1}{2}$ to 5 times the diameter of the waist of the stack; the nozzle distance x would then become $1\frac{1}{2}d$.

In section V. we saw that it is well when H is given to make the value of l and x as follows :

$$l = (0.6 \text{ to } 0.7)H$$
$$x = (0.4 \text{ to } 0.3)H.$$

---

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen.*

In America it is well known that a considerably higher vacuum is used than in Germany. According to an article by Herr von Bornes, published in the *Annalen für Gewerbe und Bauwesen* in 1892, page 223, this vacuum frequently amounts to as much as from 12 inches to $15\frac{3}{4}$ inches of water. This unavoidably causes a large quantity of sparks to be carried through the tubes and is the reason for the application of the large smokebox; for, in this way, the particles of coal that are carried through the tubes can be collected in the front end and the ample space provided enables this to be done without quickly clogging the lower tubes and thus interfering with the steaming capacity of the boiler.

From this we may take as approximately the average values as follows :

IV. $\begin{cases} l = 0.666H = \frac{2}{3}H \\ x = 0.333H = \frac{1}{3}H. \end{cases}$

From III. we now have

$x = 1\frac{1}{2}d$, which gives $1\frac{1}{2}d = \frac{1}{3}H$, or

V. $H = \frac{9}{2}d = 4\frac{1}{2}d.$

The total height H of the stack is thus made dependent upon the diameter d of the waist. But it can, nevertheless, be increased a few inches without any hesitation.

Fig. 76 shows the necessary division of the total height of H into the nozzle distance x and the stack length l in accordance with what has just been said.

If we bear in mind the foregoing comparisons for the principal dimensions of the conical stack having a flare of one-sixth and using the diameter of the waist d as the unit of measurement we will have $l = 3d$, and the upper diameter of the stack $= 1\frac{1}{2}d$, which thus becomes the same as the nozzle distance x.

The ratios existing between the several dimensions of a locomotive stack are thus shown to be of the very simplest nature, as still further shown by Fig. 77.*

These ratios have been proven to be accurate and available for use not only on ordinary locomotives, as demonstrated in numerous cases, but on the whole range of express, passenger and freight locomotives, as well as upon switching engines. For compound locomotives, on the other hand, a further change is required, as an application to them has demonstrated. In consequence of their having only two exhausts for each revolution of the crank, the stack, in order to produce the same effect upon the fire, must either be somewhat smaller or somewhat longer than in the comparitive dimensions given above, provided it is not thought best to modify the calculation of the increased total height by the use of a wider bridge. Experiments made on four coupled compound express passenger locomotives built at Erfurt and Hanover and six coupled compound freight locomotives gave a satisfactory working of the smokestack, if the total height was equal to five times the diameter of the waist; that is, when $VaH = 5d$, and, likewise, when $l = 3\frac{1}{2}d$. The above ratio of stack could then be taken as in the ordinary locomotive.

The foregoing rules are for conical stacks that have a flare of one-sixth over their whole length. If we wish to use a stack having another inclination, it is necessary, as we have already shown in connection with Fig. 74, to make a corresponding adjustment of the diameter of the waist as calculated in table XXVIII. for the new flare. This must be positive for a flare less than $\frac{1}{6}$ (as $\frac{1}{12}$, $\frac{1}{20}$, etc., for example), and negative for such as are greater than $\frac{1}{6}$ (as $\frac{1}{5}$, $\frac{1}{4}$ etc., far example). It is merely stipulated that, according to

Fig. 76.

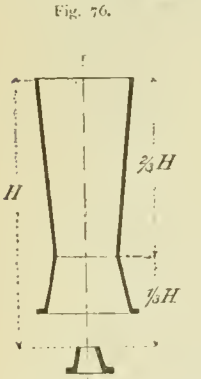


Fig. 77

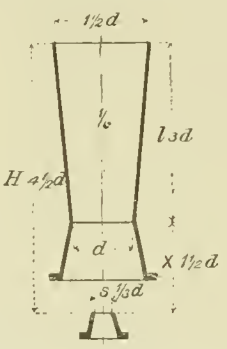


Fig. 78.

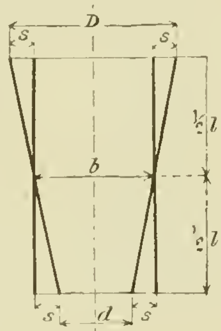


Fig. 73, the average cross-sectional area located at a distance of $\frac{1}{3}$ above the waist should remain the same. The length of l_1 may, however, change with the diameter d, according to the following observations :

According to Fig. 78, let the upper diameter, at a distance l^1 from the waist, be represented by D; let σ be the average diameter, and s one-half of the difference between the largest and the smallest diameters, hence we have for a stack with a flare of $\frac{1}{6}$:

$$D = d + \tfrac{1}{6}\, l^1$$

$$D = d + 4\, s \text{ and}$$

$$l^1 = 24\, s$$

The average diameter is

$$\sigma = d + 2\, s = d + \frac{l^1}{12}$$

which gives

VI. *a* $\quad l^1 = 12\,(\sigma - d).$

Hence, as the cross section of a cylindrical stack is equal to $1\frac{1}{2}$ times that of the corresponding conical stack having a flare of $\frac{1}{6}$, we also have

$$\sigma = 1{\cdot}2247\, d$$

whence we obtain from VI. *a*

VI. *b* $\quad l^1 = 2.6964\, d = \infty\ 2.7\, d.$

By this equation we obtain from V. the resulting ratio of

$$d = \tfrac{2}{9}\, H,$$

whence we obtain from l^1 the simple equation

$$l^1 = 2.7 \times \tfrac{2}{9}\, H$$

or

VI. *c* $\quad l^1 = 0.6\, H.$

Whence the simple length of stack l (see Fig. 76) is, according to 12, equal to $0.666\ldots H$, so that it happens that for the change in the flare of the stack, the corresponding length l' is about $\frac{1}{15}\, H$ shorter than before. Therefore if we wish to keep the length l constant it will be necessary to enlarge the stack.

In the summary given at the conclusion of this paper, the differences between the diameters of the cylindrical and equivalent conical stacks having a flare of $\frac{1}{6}$ is given in a separate column; which was averaged from a series of experiments with an indicated stack, and calculated.* If this difference be multiplied by 12 in accordance with VI. *a* we will have l'.

If the diameter of the cylindrical stack is not calculated, l' will either be fixed according to VI *b* or, simpler still, according to VI. *c*. In compound locomotives l' will likewise be as large as in ordinary locomotives. If H be assumed then l' will be equal to $0.54\ H$, according to the first and larger values of $H\ (= 5\, d)$.

As soon as l' is determined, then the necessary enlargement of the waist of a stack having a flare of $\frac{1}{6}$ can be calculated. An example may make this clearer.

Let us take, for instance, a locomotive having a grate area of 24.74 square feet, the sectional area of the cubes being 3.12 square feet. According to equation I and table XXVII, a conical stack having a flare of $\frac{1}{6}$ will have a sectional area at the waist. $fs = .37 \times 3.12 = 1.15$ square feet, which gives $d = 14.57$ inches and $H =$

---

* With regard to the construction of locomotive smokestacks the recommended practice of $x = \frac{1}{3}H$ should be especially referred to Section V*b*. It will be remembered that it was there shown that the lower third of the total height of the stack is without any marked influence on the action of the draft, provided that the jet of steam with its entrained accompaniment of the products of combustion find a free entrance. The latter statement tallies with the relative width of stacks that were laid down in Table XXVIII. It is, therefore, from this fact that a particular shape at this point is a matter of no moment; that the so called "foot" of the stack has been developed. It will even be found that the stack can be lengthened downward a certain amount, thus lengthening l and shortening x, and also at the same time contracting the new diameter of the waist without in any way materially injuring the efficiency of the action of the stack. For this reason it is my opinion that many of the special bases and stacks that have been cast for individual locomotives have been a waste of time, money and trouble. They are only suitable where the distance from the nozzle to the top of the smoke-box is greater than $1\frac{1}{4}d$, or where the shell of the stack-pipe projects through the plating and comes down into the smoke-box.

* Example 1. The eight-coupled consolidation compound freight locomotive of the Prussian State Railway required, according to the conclusion given in the general review in Section XII., and with a stack having a flare of $\frac{1}{6}$, a diameter of waist of 16.14 inches, with the total height $H = 5 \times 16.14 = 80.7$ inches; $l = 3\frac{1}{2} \times 16.14 = 56.49$ inches, and the nozzle distance $x = 1\frac{1}{2} \times 16.14 = 21.21$ inches. The nozzle diameter thus becomes $\frac{1}{3} \times 16.14 = 5.71$ inches. If we make the flare of the stack $\frac{1}{12}$ instead of $\frac{1}{6}$ the diameter of the waist must be made $16.14 + 1.81 = 17.95$ inches, whence l^1, according to equation VI.*b* is equal to $2.7 \times 16.14 = 43.58$ inches.

Owing to the high position of the boiler on this locomotive it was impossible to get a total height of stack of 80.7 inches. In fact it could only be made about 53.14 inches. The calculated stack had, therefore, to be shortened about 27.56 inches, which means that the length l was $56.59 - 27.56 = 29.03$ inches. According to Plate IV., under IV. it appears that a funnel-shaped stack, 4 feet 9.68 inches long, when shortened 27.56 inches, shows a diminution of the vacuum of about .87 inches of water, the abscissas being $24.21 + 17.52 = 41.73$ inches and the nozzle diameter 5.32 inches. The shortened stack must then be given such an increase of flare that this lowering of the vacuum will be compensated. According to the said Plate IV., we find that this contraction will amount to about 1.97 inches; for the stack with a flare of one-twelfth, with a diameter of 15.75 inches, when shortened 27.56 inches, shows a vacuum of 3.7 inches at an abscissa of 3 feet 5.73 inches, which with a stack of the same length, but having a diameter of 13.78 inches, shows a vacuum of 4.69 inches, both nozzles having a diameter of 5.32 inches (a mean between 5.51 inches and 5.12 inches), or a difference of .99 inches. The diameter of the waist, which was 17.95 inches, thus becomes in the new stack of one-twelfth flare only about $17.95 - 1.97 = 15.98$ inches, with a length $l = 28.94$ inches and a nozzle distance $x = 24.21$ inches. The eight-coupled consolidated locomotive in question worked satisfactorily with a waist diameter of 15.75 inches; a length $l = 28.55$ inches and a nozzle distance $x = 24.02$ inches, while the nozzle diameter is 5.12 inches.

Example 2*a*. The eight-wheeled, four-coupled compound express locomotive of the Prussian State Railway permits the use of a total height of stack H of about 5 feet 4.96 inches, provided the nozzle is not placed below the upper row of tubes. According to the statement already made, the stack having a flare of $\frac{1}{6}$ must have a waist of 14.53 inches in diameter; H would then be equal to $5 \times 14.53 = 72.65$ inche in round numbers; $l = 51.18$ inches and $x = 1\frac{1}{2} \times 14.53 = 21.78$ inches in round numbers, and the nozzle diameter must be 1.86 inches. The calculated length of stack thus becomes 7.87 inches shorter, that is to say l will be equal to 43.31 inches. According to Plate IV. under IV., the length of a funnel shaped stack with a flare of $\frac{1}{12}$ is 4 feet 9.68 inches, with a nozzle diameter of 4.74 inches and a diameter itself of 15.75 inches, producing a vacuum of 4.09 inches, which drops to 3.94 inches, with a stack length of 4 feet 3.18 inches, and to 3.66 inches, with a length of 3 feet 7.31 inches. Shortening the stack 7.87 inches also lowers the vacuum from 3.94 inches to 3.66 inches, or .28 inch. This slight fall can best be met by the application of the bridge.

According to Plate VI. under D, with an abscissa of $21.65 + 17.52 = 39.17$ inches, the vacuum of a funnel-shaped stack 4 feet 9.68 inches long, with a flare of $\frac{1}{12}$ and a diameter of 15.75 is increased about .37 inch by cutting down the stack 15.75 inches at the top, if, at the same time, instead of a nozze 4.74 inches in diameter one with a bridge .63 inch wide and 5.12 inches in diameter is used. But since, in this case, compensation must be made for only .27 inch, a somewhat narrower bridge can be used. This locomotive, with a stack having a flare of $\frac{1}{12}$, a diameter of 16.11 inches (having been substituted for one with a flare of $\frac{1}{6}$ and a diameter of 14.53 inches) with $l = 43.31$ inches $x = 21.65$ inches and a nozzle 5.12 inches in diameter provided with a bridge, generated sufficient steam for its work and yet threw less sparks than the old and smaller stack had done.

b. The same good results were also obtained with a stack .59 inch smaller, while the other dimensions were kept the same as in the stack of 16.14 inches diameter just mentioned. According to the plates, the vacuum was increased about .27 inch by this contraction of .59 inch. If a bridge .35 inch wide is used the diameter of the nozzle can be increased to 5.28 inches.

c. By dropping the nozzle down below the top row of tubes, the calculated total height, $H = 6$ feet 0.84 inch, of stack can be obtained. On an eight-wheeled, four-coupled compound express locomotive, the fire was worked in a satisfactory manner, with a cylindrical stack having a diameter of 17.72 inches, a length of stack proper of 4 feet 2 inches, a nozzle distance of 22.84 inches and a nozzle diameter of 5.12 inches provided with a bridge .31 inch wide, and this too when the engine was severely crowded.

$4\frac{1}{2} \times 14.57 = 65.66$ inches, = 5 feet, 5 .66 inches, l' will then he equal to 2.7×14.57 or $0.6 \times 65.66 = 39.4$ inches (1. m.).

whence $\frac{l'}{2} =$ 19.7 inches. (500 mm.).

In a height of 19.7 inches the contraction at the bottom is the same as the widening at the top.

In stacks with $\frac{1}{6}$ flare we have $\frac{19.7}{6} = 3.28$ inches.
" " " $\frac{1}{8}$ " " $\frac{19.7}{8} = 2.46$ "
" " " $\frac{1}{10}$ " " $\frac{19.7}{10} = 1.97$ "
" " " $\frac{1}{12}$ " " $\frac{19.7}{12} = 1.64$ "

Etc.

Again the stack with a flare of $\frac{1}{6}$ has a smaller waist than the—
Stack with a flare of $\frac{1}{8}$ by $3.28 - 2.46 = .82$ inch.
" " " $\frac{1}{10}$ " $3.28 - 1.97 = 1.31$ inches.
" " " $\frac{1}{12}$ " $3.28 - 1.64 = 1.64$ "

Thus the adjustments $2\,s$ for the diameter of the waist calculated in accordance with Table XXIII. are established.

By maintaining a greater diameter of stack at the waist, the nozzle distance, as calculated according to equation III., remains unchanged as well as the total height H, together with the nozzle diameter that was calculated according to II. *b*. Now, if our stack having a flare of $\frac{1}{6}$ is replaced by one with a flare of $\frac{1}{12}$, the diameter of the latter would then be, in round numbers, $14.57 + 1.61 = 16.18$ inches. It would have a total height of $H = 14.57 \times 4.5 = 65.57$ inches, $l = \frac{2}{3} \times 65.57 = 43.78$ inches, and the nozzle distance $x = \frac{1}{3} \times 65.57 = 21.88$ inches, while the diameter of the nozzle itself would be $\frac{1}{3} \times 14.57 = 4.86$ inches.

If we make an application of these dimensions to a compound locomotive having the same grate area and sectional area through tubes, H and l will be increased by about $\frac{1}{2}\,d$, so that $H = 72.84$ inches and $l = 50.98$ inches. All of the other dimensions, as well as the converted length l', will be the same as in the ordinary locomotive.

From the foregoing discussion of the change in the flare of the stack it is evident that advantage should be taken of its peculiarities if the dimensions of different stacks are to be so adjusted as to make a comparison of their action with each other. To do this they must be changed to the same flare; furthermore, it is also necessary to bear in mind the different nozzle distances, that these may also he made the same for the purpose of a calculation, and whether the stack itself has actually been lengthened or shortened. Then a fresh comparison of the stacks with reference to their diameters and lengths becomes possible.

In this way it is often found that on locomotives with ratios already established the stack is too small for a large nozzle opening, and on the other hand the stack is too large for the small opening. According to the deductions obtained from sections III. to V., the same vacuum can be produced with both arrangements. According to the statement made in V. *e* the latter arrangement (the large stack) is usually the one to be preferred, especially, and this must be distinctly emphasized—there should never be too great a contraction of the nozzle opening (the calculation being correct) lest there be a corresponding back pressure put upon the steam piston, as a result, as was clearly shown by the Templekof experiments. This inter relationship existing between the stack and the nozzle must be kept constantly before the eye in the determination of the dimensions to be given to these parts. No accurate rule for the influence and action of the draft upon the fire is rendered possible by the knowledge of the dimensions of only one of these parts. *The stack and the nozzle must, rather, always be examined together.*

According to the deductions obtained from Section XI., it is seen to be purely a matter of taste as to what shape of stack shall be used, whether cylindrical or conical, especially as the cost scarcely enters into the question.

When it so happens that the height available in the construction is not as much as that demanded by equations V and V_a, then the shortened stack must be made correspondingly smaller. The lines of the diagrams in Plates III. and IV. show this without any further rule. If the stack is made a few inches longer than the established length, as in the case of a tank locomotive, for example, where it was done for the sake of avoiding a smoke annoyance to the men: then, if the action of the draft is to be kept the same, it must be made larger in diameter according to Table XXVIII. The Plates mentioned also give the necessary data.

It must be remembered just here that the value of the vacuums given in these tables must be understood to be only approximations for general application. They were obtained on the experimental apparatus under the conditions existing on a passenger locomotive, and therefore coincide in the first line with that of those locomotives of similar conditions and sizes. But the latter ones are only definite for the first position of the air openings; still, as the draft ratios of all locomotives are very much alike, the results obtained by these experiments can be adapted to a general application and the plates admit of being transferred to locomotives of a different kind.

For the purpose of making an average of the conditions prevailing in practice, locomotive experiments were instituted, using both pure Silesian coal and a half and-half mixture of this and of Westphalian coal. When a stack designed in accordance with the foregoing rules failed to make steam enough on account of the fuel used, the draft could be readily adjusted and made sufficient by the application of a bridge to the nozzle.

Still, it is not alone the kind of fuel that influences the draft in a way that the formulæ cannot be applied in a definite manner, but particularly that wide variety of arrangement that prevails in the designs of locomotive boilers and their appurtenances, such as similar grate areas and sectional areas through the tubes. Greater length of flues and closer meshes in the spark arresters may likewise diminish the draft and necessitate a variation from the calculated dimensions. The simplest way of meeting this difficulty is, as we have already demonstrated, by the application of a bridge to the exhaust nozzle. Suppose, for example, that the draft is too weak, it can readily be strengthened by the application of a bridge of a suitable width, while *the diameter of the nozzle is also increased*. Suppose it is too strong, it is, on the other hand, merely necessary to bore out the nozzle to a larger diameter, or, in case a bridge is already there, it can be made narrower or a smaller one substituted in its place. By this means, especially on the trial of a new type of locomotive, we can advantageously make the change if we desire to test the steam-generating qualities. Likewise, it may be desirable to furnish the driver with a few bridges of different widths and depths that vary from each other by from .05 to .10 inches, with instructions to try them one after another until the best possible draft on the fire is obtained.

In most cases a bridge from .20 inch to .27 inch in width and from .16 inch to .20 inch in height will suffice for increasing the draft a suitable amount, so that in general the nozzle may be made a few hundredths of an inch larger in diameter than that called for by the calculations. It was also shown by the experiments mentioned above that no marked increase in the back-pressure on the pistons is to be feared as the result of the application of so small a bridge. But if it is desired to make a considerable increase in the strength of the draft it becomes necessary to adopt a

Fig. 79

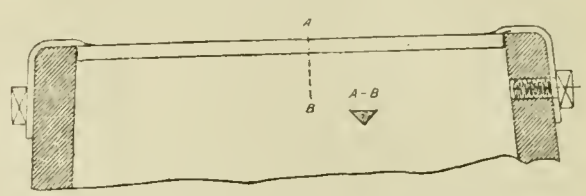


Fig. 80.

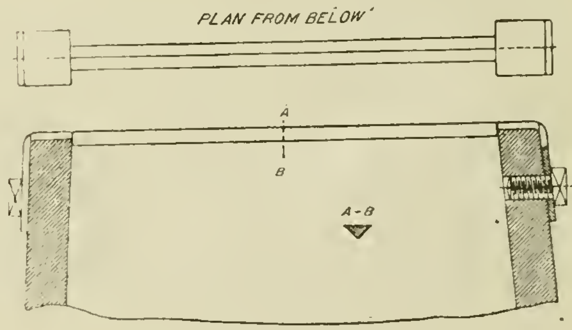
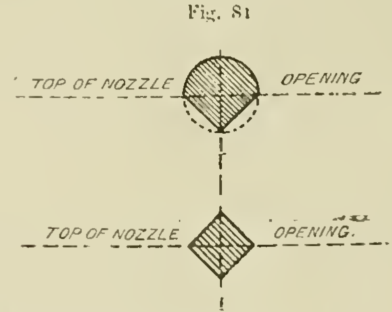


Fig. 81



wider bridge, say from .39 inch to .47 inch, and at the same time increase the diameter of the nozzle from .20 inch to .39 inch, by which means the steam jet will be given a sharper divergence and thus fill the stack more quickly. An example of this is furnished by the case of an eight wheeled, four-coupled Erfurt locomotive, the diameter of whose nozzle was calculated at 5.02 inches, but which was actually made 5.12 inches, and a bridge .31 inch applied. In consequence of this, with a conical experimental stack 14.96 inches in diameter at the waist and a flare of $\frac{1}{6}$ (the length being like that given in the annexed review at the conclusion of this article), the calculated nozzle distance could be decreased from 22.44 inches to 8.5 inches. In the same way on a locomotive of similar construction, a cylindrical stack, having a diameter of 18.70 inches, was taken instead of the calculated size of 18.31 inches, since the same nozzle (5.02 inches in diameter) was enlarged to 5.19 inches, and a bridge 43 inches wide applied. In both cases the consumption of fuel and the generation of steam was satisfactory.

With the cylindrical stack the nozzle opening was placed so low that it was almost flush with the top row of tubes, so that the proper constructional height H was obtained. It is well known that this low location of the nozzle has had many applications on the large English locomotives, among others on the so-called single-driver engines of the Great Northern Railway, which, with drivers

8 feet, 2½ inches in diameter, haul the fast express trains from London to the North; and also on the Webb three-cylinder compound locomotives of the London and North Western Railway.

The use of the bridge is to be recommended in a general way in all cases where it is desired to increase the draft in accordance with Sections VII. and IX., and thus it becomes necessary, under these conditions, to enlarge the nozzle or the stack, or shorten the nozzle position and with it the total height H of the stack. As already emphasized in section VII., it is not always possible to arrange to get the full height of stack H, especially in locomotives where the boiler is very high, so that, in compound locomotives for example, the values ranges from $4\frac{1}{2}d$ to $5d$.

The making and application of the bridge must, of all things, not be left solely in the hands of the locomotive engineer, since they are apt to use forms and dimensions that are wholly unsuited for practical working, as experience has shown. There are in the possession of the principal workshops at Tempelhof a large number of such false bridges of somewhat odd shapes, which not only utterly failed to accomplish their purpose, but by their great contraction of the nozzle actually had a detrimental effect upon the consumption of coal and were, therefore, removed from the locomotives.

For the nozzle positions obtained from equation III. the form of bridge illustrated in Figs. 79 and 80 is recommended. The greatest width of bridge in this case lies flush with the top of the nozzle. In the arrangement illustrated in Fig. 79 the nozzle hood is held by two .27-inch tap bolts which serve to hold the bridge in position. In the same way copper hoods may be made of this convenient form, which may be used for the purpose of raising the nozzle opening above that of the original cast-iron hood. In the form of bridge shown in Fig. 80 there must still be a small cutting away of the nozzle edges at two places. Both bridges can be quickly put in position and also easily removed.

Since observations with the apparatus have shown that a vacuum in the steam cone exists directly over the bridge for its whole length, it is not necessary that the upper surface should be flat, as shown in Figs. 79 and 80. But it can rather be made crowning, as shown in Fig. 81, by cutting the bridge out of round iron, or three-cornered by using square iron, or of any other convenient form, provided only that the lower portion lies flush with the top of the nozzle and is wedge-shaped.

The customary treatment at the Tempelehof shops is to determine the relative ratios of the stack and blast nozzle of each incoming locomotive. On the basis of these investigations several faulty contractions of the nozzle and unsuitable forms of bridges have been set aside and likewise, in some cases, stacks that have been too small have been replaced by larger ones that were more suitable. It is, therefore, self-evident that special value should be placed upon a careful adjustment of the ratios of stack and nozzle, since, as we know, a slight variation of one or the other may result in a marked weakening of the action of the draft.

In all of the cases cited up to this time, there is an economical advantage presented that is entirely independent of the decrease in the throwing of sparks and the consequent lessening of the dangers of fire.

It must be admitted that in many ways the suitable dimensions of stack measurements are still undervalued. These are quite necessary in order to come to a correct conclusion regarding a locomotive and should therefore always be used. But it must not be thought that the diagrams can never fail in the slightest particular.

In conclusion the method of calculating stacks and nozzles may be briefly summarized as follows:

a. Conical Stacks.

We ascertain the smallest diameter, d, of a stack of $\frac{1}{6}$ flare from Table XXVIII., according to the size of the grate area and the sectional area through the tubes, taking for the ordinary locomotive $H = 4\frac{1}{2}\ d$, then $\frac{1}{3}\ H$ gives the nozzle distance $x\ (= 1\frac{1}{2}\ d)$ and $\frac{2}{3}\ H$ the stack length $l\ (= 3d)$.

For compound locomotives we will have $H = 5d$, $x = 1\frac{1}{2}d$, $l = 3\frac{1}{2}\ d$. The nozzle diameter will usually be $\delta = \frac{1}{3}\ d$, or when a bridge of from .20 inches to .39 inches is used, $\delta^1 = \frac{1}{3}\ d$ + (.12 inch to 35 inch). (The most effective width of bridge for a nozzle diameter δ must be ascertained practically.)

As we change the flare of the stack from $\frac{1}{6}$ to some other $\frac{1}{n}$ ($\frac{1}{8}$, $\frac{1}{10}$ etc.), a larger waist must be used. For this purpose we may make d about

$$w\ H\ \frac{\frac{1}{2}l^1}{6} - \frac{\frac{1}{2}l^1}{n} - \frac{l^1}{2}\left(\frac{1}{6} - \frac{1}{n}\right)$$

wider, and at the same time, the diameter of the stack D lying at the distance l^1 above the waist must be made correspondingly smaller (see Fig. 78), whence $l^1\ H\ 0.6\ H$ for simple locomotives and $l^1\ H\ 0.54\ H^1$ for compound locomotives. Suppose we adopt, as is perfectly practicable, $\frac{1}{12}$ for the flare of the stack, then the increase in the diameter of the waist becomes $w\ H\ \frac{l^1}{24}$ for both kinds of locomotives, or in terms of $H\ w\ H\ \frac{H}{40}$ for simple locomotives and $w\ H\ \frac{H^1}{44.4}$ for compound locomotives.

All other ratios remain unchanged under these conditions.

b. Cylindrical Stacks.

We may calculate the diameter either from Table XXVIII. or from the previously calculated diameter of the waist of an equivalent conical stack width of flare of $\frac{1}{6}$.

In the latter case we will have

$$d \text{ cyl.} = 1.2247\ d \text{ con.}$$

The nozzle diameter

$$\delta = \frac{1}{3.67}\ d \text{ cyl.} = \frac{1}{3}\ d \text{ con ;}$$

further for simple locomotives.

$$H = 3.674\ d \text{ cyl.} = 4\frac{1}{2}\ d \text{ con.}$$
$$l = 3.450\ d \text{ cyl.} = 3\ d \text{ con.}$$
$$x = 1.225\ d \text{ cyl.} = 1\frac{1}{2}\ d \text{ con.}$$

for compound locomotives we will have

$$H = 4.080\ d \text{ cyl.} = 5\ d \text{ con.}$$
$$l = 2.855\ d \text{ cyl.} = 3\frac{1}{2}\ d \text{ con.}$$
$$x = 1.225\ d \text{ cyl.} = 1\frac{1}{2}\ d \text{ con.}$$

TABLE XXIX.

Construction of Locomotive (single expansion).	Grate area.	Sectional area through tubes.	Stack diameter. Conical, $\frac{1}{6}$.	Stack diameter. Cylindrical.	Nozzle diameter.	Nozzle distance. x.	Stack length. l.	Total height. H.	Difference between cylindrical and conical diameter.	Length l' due to the change of flare from $\frac{1}{6}$.
	sq. ft.	sq. ft.	inches.	inches.	inches.	inches.	inches.	inches.	inches	inches.
*4 Coupled, 6-wheeled passenger	20 13	2.80	13.57	16.65	4.53	20.39	40.79	61.19	3 08	36.81
*4 " 6 " express	22.28	2.63	13.27	16.26	4.41	19.92	39.84	59 77	2.99	35 87
†*4 " 8 " " with bogie truck (Erfurt)	24.76	3.29	14.92	18.29	4.98	22.40	44.81	67.21	3.37	40.39
†4 " 8 " " " " " (Hanover)	24.44	3.11	14.51	17.80	4.86	21.81	43.63	65.13	3.29	39 37
†*6 " 6 " freight	16.47	3.17	14.29	17.52	4.78	21.46	42.91	61.37	3.23	38 66
6 " 8 " "	24.76	3.77	16.02	19.63	5.35	24.02	48.03	72 05	3.61	43.23
8 " 8 " "	24.23	3.60	15.55	19.06	5.19	23.35	46.70	70.04	3 51	42 05
8 " 10 " "	24.76	3.83	16.16	19.80	5.39	24.25	48.50	72 76	3.61	43.70
4 " 8 " double freight with bogie drivers	20.88	3 73	15.69	19 23	5.24	23.54	47.09	70.47	3.51	42 44
4 " 4 " for branches	15.61	2.91	13 62	16.65	4.53	20.43	40.87	61.30	3 03	36.81
*6 " 6 " tank for branches	14.00	1.89	10 95	13.41	3 66	16.42	32.83	49 25	2.46	29 53
4 " 6 " " " main lines	15.03	2.41	12.40	15.20	4.13	18.62	37.24	55.87	2.80	33.50
4 " 6 " tank, pass., for main lines	17.19	2.57	12.87	15.79	4.29	19.29	38 58	57.88	2 92	31.81
4 " 8 " " " " " "	17.19	2.50	12.72	15.59	4.25	19.10	38 19	57 29	2 87	34.45
6 " 8 " " for main line	16.47	2.77	13.35	16.34	4 45	20.04	40 08	60.12	2.99	35.98
*4 " 6 " passenger (old type)	19.38	2.78	13.48	16.51	4.49	20.21	40.47	60·71	3.06	36.50
*6 " 6 " freight (" ")	15.61	2.95	13.70	16.79	4.57	20.55	41.10	61.66	3 09	37.01
6 " 6 " " (new ")	16.62	3.38	14.84	18.19	4.98	22 28	44.57	66 85	3.35	40 16
*4 " 6 " tank, pass., (old type)	13.40	2.19	11.73	14.37	3.90	17.60	35.20	52.79	2.64	31 65
*4 " 4 " " (old type)	10.62	1.56	9.80	12.05	3.27	14.76	29.53	44.29	2.25	26 61

REMARKS.

1. The change of the stack with a flare of $\frac{1}{6}$ for one of a lighter flare, but larger waist follows from the rules given in Section XII.
2. Such a change may be an equivalent.
3. The total height of the stack as well as the nozzle distance can be obtained within a few fractions of an inch.
4. In compound locomotives the length l and the total height H is about one-half the diameter of the stack (the flare being $\frac{1}{6}$ greater), all other dimensions remaining unchanged.
5. The locomotives in the table marked (*) and (†) indicate that the experimental stacks of the dimensions given were tested in service, and this was done, with the exception of the four-coupled six-wheeled express locomotives, both with the conical and cylindrical forms. The simple engines are marked (*) and the compound (†).

The Situation in China and Japan.

(WRITTEN FOR THE AMERICAN ENGINEER.)

It is to the interest of American manufacturers of railroad material, cars, etc., that they should understand the changes in China effected by the late war in Japan. Before the peace of Shimonoseki, the Chinese mandarins violently opposed the introduction of any innovation, threatening to do away with their influence and perquisites. But since peace was restored, two powerful influences have been at work among them. First comes the hatred inspired by the success of the despised Wo-Jin, or pigmies, as they contemptuously name the Japanese; and second the fear of dismemberment unless China acquires the means of consolidating her strength. Besides these impulses working internally, the Japanese have been instrumental in removing the barrier which kept the interior of China closed to foreign enterprise. This fact is so important that some space may be devoted to an explanation.

When peace negotiations between Li Hung Chang and Marquis Ito were in progress in Shimonoseki, the Japanese Prime Minister feared that England would object to the cession of the Liao Tung Peninsula. To propitiate this power, Ito insisted upon the insertion of the following three clauses :

1. The opening of several new ports.
2. The right of Japanese subjects to manufacture in the open ports of China; and
3. The abolition of the li-kin duty.

As to the first clause, this was simply establishing so many new markets for foreign products; but as these ports are situated in the poorer districts of China, the advantage to foreigners was not great. Another thing, however, was the second clause. The right of manufacturing had been reserved to the mandarins, but by the "favored-nation" clause of China's treaties with other nations, no privilege whatever can be granted to any nation which is not shared by all alike. This clause, then, threw China open to foreign manufacturers, and many were not slow to avail themselves of cheap wages, cheaper coal and transportation.

But the most important of all clauses was the abolition of the li-kin duty. The import duty in China is almost uniformly 5 per cent. *ad valorem*, and is immutable, being regulated by treaty, while China neither demands nor is likely to obtain tariff autonomy within our lifetime. But the mandarins have appropriated to themselves the right to collect a toll on all merchandise passing through their territory. The rivers are the great arteries of trade, but these magistratures are very close together, so that the frequency of this toll acted in reality as a prohibitory tariff. Its abolition has therefore opened China to foreign manufactures.

Up to the close of the war the only railroads existing in China were from Tientsin to Shanhai Kwan, 25 miles, and from Tientsin to the Kai Ping coal-fields owned and operated by Li Hung Chang. This last-named road is 67 miles long. Both roads are the property of the wealthy viceroy, but are wretchedly equipped and managed. Li Hung Chang's great rival in power was and is to-day Chang Chih Tung, who, while still in Peking, advocated the construction of railroads, but with Chinese capital and under China control. Through Li Hung Chang's influence he was appointed viceroy of the two Kiangs' wealthy provinces about the Yang-tse River, and of which Nanking is the capital. Here he was told to carry out his projects, and he proceeded to do so in a characteristic Chinese way.

He decided first to intrust the building of railroad shops to a nationality not powerful enough to make its influence felt, and his choice fell upon Belgium. He engaged as chief engineer Mr. Paul de Hees, who had constructed many of the railroads in Turkey, and a staff of engineers of the same nationality and located the shops at Hankow, 400 miles up the Yang-tse. The work was, however, taken up and carried on in a most desultory and unsatisfactory manner until after the close of the war. Surveys have been made for the line between Nanking and Peking, a distance of 1,407 miles, and the work is now going on with more energy.

Mr. de Hees is a great admirer of American railroads and railroad material. He has visited this country, and is determined to closely follow the system in use here. A Belgian firm in Shanghai, Messrs van der Stegen & Company, are the financial agents. Here, then, would appear to be an opportunity that should not be neglected.

For energy and commercial enterprise in that part of the world the Baldwin Locomotive Works, of Philadelphia, Pa., deserve great commendation. After the World's Fair they despatched Capt. W. H. Crawford to Japan, and he succeeded, after a severe trial on the steep Gotemba grade, in the Hakone Mountains, in convincing the Japanese of the superiority of the American over the British engine. Since that time he has sold to the Japanese government and various private railroad companies over 120 locomotives, besides a number to the Russian-Siberian Railroad in Vladivostok. The same company has recently obtained an order from the Chinese government.

This action on the part of the Baldwin Locomotive Works proves conclusively that in China and Japan we can compete with any nation in Europe. In fact, we have the advantage in the time necessary to fill orders, and in cheap transportation. There are at present six steamship companies, with an aggregate of 20 steamers plying between the Pacific Coast and China, calling at Japanese ports. Besides these there are the Perry and Barber lines running from New York through the Suez Canal to Yokohama and calling at Chinese ports. The freight via these lines ranges between $5 and $6 per ton.

The Society of Mechanical Engineers.

The programme of the December meeting of the American Society of Mechanical Engineers shows that at the opening session, Tuesday, Dec. 1, John Fritz will read the president's address on the "Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer to It." On Wednesday morning these papers are to be presented: "An Historical and Technical Sketch of the origin of the Bessemer Process," by Sir Henry Bessemer; "Ancient Pompeian Boilers," by Wm. T. Bonner; "The Moment of Resistance," by C. V. Kerr; "Work Done Daily by a Refrigerating Plant and Its Cost," by Francis H. Boyer; "Promise and Potency of High Pressure Steam," by R. H. Thurston. The afternoon session will be devoted to addresses in memory of J. F. Holloway.

Thursday morning will be devoted to the following papers: "Experimental Investigation of the Cutting of Bevel Gears with Rotary Cutters," by F. R. Jones and A. L. Goddard; "The Calibration of a Worthington Water Meter," by J. A. Laird; "Contraction and Deflection of Iron Castings," by Francis Schuman; "A 200-foot Gantry Crane," by John W. Seaver; "Washing of Bituminous Coal by the Lubrig Process," by J. V. Schaefer; "Friction H.-P. in Factories," by C. H. Benjamin. In the afternoon these papers will be presented: "Some Special Forms of Mechanical Computers," by Frederick A. Halsey; "Rustless Coatings for Iron and Steel," by M. P. Wood; "A Method of Shop Accounting to Determine Cost," by H. M. Lane; "Tests of Fireproofing Material," by H. de B. Parsons.

Friday's session will be occupied with the following papers: "The Efficiency of the Boiler Grate," by W. W. Christie; "Efficiency of Boiler Heating Surface," by R. S. Hale; "Paper Friction Wheels," by W. F. M. Goss; "Steam Engine Governors," by Frank H. Ball; "Metric vs. the Duodecimal System," by Geo. W. Colles, Jr.; "Aluminum Bronze Seamless Tubing," by Leonard Waldo, and "The Photographing of Machinery," by Leonard Waldo.

Association of Railway Superintendents of Bridges and Buildings.

At the annual meeting of this Society at Chicago in October, the following officers were elected:

President, James Stannard, Wabash.
First Vice-President, Walter G. Berg, Lehigh Valley.
Second Vice-President, Joseph H. Cummin, Long Island.
Third Vice-President, Aaron S. Markley, Chicago & Eastern Illinois.
Fourth Vice-President, R. M. Peck, Missouri-Pacific.
Secretary, S. F. Patterson, Boston and Maine.
Treasurer, N. W. Thompson, Pittsburgh, Fort Wayne & Chicago.

The following subjects were selected for committee reports to be presented at Denver next year:

1. Methods of Heating Buildings where Three or More Stoves are now Used.

2. The most Suitable Material for Roofs of Buildings of all Kinds.
3. Round-house Construction, including Smoke-Jacks and Ventilators.
4. Care of Iron Bridges after Erection.
5. How to Determine Size and Capacity for Waterways.
6. Protection of Railroad Buildings and other Structures from Fire.
7. Designs for Ice Houses.
8. Best End Construction for Trestles Adjoining Embankments.
9. Bridge Warnings for Low Overhead Structures.
10. Stockyards and Stocksheds, Including all Details of Construction.
11. Floor System on Bridges, Including Skew Bridges.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

The Goubert Water Tube Feed Water Heater. The Goubert Manufacturing Company, New York. 48 pages. 6 by 9 inches. (Standard size.)

In March, 1895, we noticed and criticised a catalogue which was issued by the above company about that time. The burden of the criticism was that the commendation of the heater came first and the explanation of its construction afterward, and that the latter was inadequate for a full understanding of the apparatus. We have now received a new catalogue issued by the same company which is a model of its kind. It begins with an admirably clear description of "What a Feed Water is." Then the distinction between "open" and "closed" or "pressure heaters" is explained, and the objections to the former pointed out. The construction of the Goubert heater is then fully described and illustrated by sectional views, so that the wayfaring man and his coadjutant may readily understand it. A section is devoted to directions for erecting and running the apparatus, with an excellent wood engraving showing an engine-room and the disposition or location of the engine, heater, separator, steam pump, etc. Another section is on the use of heaters with condensing engines, which is followed by illustrations of several different forms, tables of sizes and price lists, and showing the percentage of fuel saved by heating feed water, and the yearly saving under differing conditions. A list of reference occupying 13 closely printed pages and a description of the Stratton separator complete the volume. It is admirably printed on best coated paper, the engravings could not be better, and altogether it is an example of the best type of this kind of literature.

Westinghouse Gas Engines. Manufactured by the Westinghouse Machine Company, Pittsburgh, Pa. 19 pages. 6 by 9 inches. (Standard size.)

This is apparently a sort of introductory volume to a fuller descriptive circular which is now in course of preparation. During the past two years Mr. George Westinghouse, Jr., has been engaged with the aid of the best obtainable engineering talent in developing and improving a form of gas engine which is illustrated and somewhat meagerly described in the publication before us. A large amount of money has been expended in experimental work and in perfecting a gas engine which it is here announced the company is now ready to supply. The general external appearance of the engine is similar to the well-known Westinghouse steam engine, but the description is only of the general features which are embodied in this new departure. New shops have been built at East Pittsburgh, and the company announce that they have abundant facilities to supply this new type of engine.

Engine and Boiler Catalogue. Houston, Stanwood & Gamble. Cincinnati, O. 32 pages. 8 by 10¾ inches.

This firm in the introduction to their circular say that they manufacture nothing but slide-valve engines, and that with good workmanship and high steam pressure that there is little difference in their economy compared with high-speed automatic engines. In the pamphlet which has been issued the different types of slide-valve engines which the firm manufactures are described with illustrations of details of different parts, reports of performance, etc. A separate section is devoted to flue and tubular boilers, with tables of dimensions, capacity, etc., and an excellent illustrated description of methods of setting boilers, boiler fronts, etc., and also an illustration and description of a coil feed-water heater which they make.

The Hancock Locomotive Inspirator, manufactured by the Hancock Inspirator Company, 51 Oliver street, Boston, Mass., 1896; 16 pages, 6 by 9 inches (standard size).

In a circular letter accompanying this catalogue the manufacturers state that they designed and placed on the market the first double-tube locomotive boiler feeder, and that their constant aim has been to produce an instrument that in simplicity, durability and efficiency will best meet the severe requirements of locomotive service. As the company's sales of Hancock Inspirators of all kinds has been more than 200,000 in 20 years, it is evident that good design and workmanship has characterized these boiler-feeders. In the present catalogue the company present three styles or types of the Hancock Inspirator, A, B and D, some one of which is interchangeable with any injector of standard manufacture now on the market. An important fact in connection with this statement is that each and every corresponding part of the three types (A, B and D) is identical in design and *interchangeable*, the only exception being the bodies, which are shaped to suit the different pipe connections, and the connecting rods and overflow cranks. This will readily be recognized as an important advantage in substituting one standard for the different makes of injectors in use and in the matter of economy when repairs may be necessary.

Besides the illustrations of these inspirators and tables of their prices, capacities and pipe connections, there is a good description of the company's patent hose strainer, which is removable for cleaning without disturbing the coupling or any pipe joints; also check-valves and steam-valves for inspirators, and the Hancock ejectors or "lifters."

Equipment Notes.

The Illinois Central is asking for bids on 1,000 freight cars.

The Lake Erie & Western will soon order some new locomotives.

The Chicago, Hammond & Western, is in the market for 100 box cars.

The Gulf, Beaumont & Kansas City will soon place orders for 40 box cars.

The order which the Baldwin works received from China was for eight locomotives.

The Mobile & Ohio has ordered six locomotives from the Rogers' Locomotive Works.

The Armour Packing Company of Kansas City is asking bids on 100 refrigerator cars,

The Fall Brook Railway is contemplating the purchase of two passenger locomotives.

The Delaware & Hudson, it is said, will order new cars and locomotives before next March.

The Wells & French Company, Chicago, are building 400 refrigerator cars for Swift & Company.

The Wabash road is in the market for 20 10-wheel locomotives, 15 for freight and five for passenger service.

The Columbus, Hocking Valley & Toledo is reported to have placed an order with the Michigan-Peninsular Car Company for 50 30-ton dump coal cars.

The Haskell & Barker Car Company is reported to have an order for 1,000 box-cars for the Chicago & Northwestern Railroad, and another 1,000 for the Wisconsin Central.

The Mount Vernon Car Manufacturing Company is building 25 refrigerator cars for the Mobile & Ohio. They will be of 60,000 pounds capacity and will be equipped with air-brakes, Gould couplers and Detroit springs.

The Barney & Smith Car Company, of Dayton, O., are completing 10 combination baggage and passenger cars for the B. & O. R. R. They are to be painted royal blue with gold striping, which has been adopted as the standard color of the road.

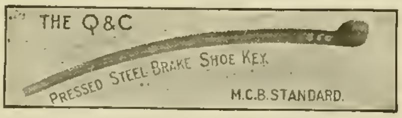
The Ohio Falls Car Company is building for the Rio Grande, Sierra Madre & Pacific Railway eight coaches, three cabooses and 150 box-cars of 60,000 pounds capacity. All the cars will have air-brakes and Tower couplers, and the box-cars will also have Winslow roofs and Q. & C. door fastenings.

A contemporary, *Hardwood*, states that a gentleman, the head of one of the largest railroad systems in the county, computes that the railways of the country will require at least 200,000 freight cars in the next two years, of which fully three-fourths will be box-cars. The construction of these cars will consume 600,000,000 feet of lumber.

Some very severe tests have been made with the royal blue tint, which has been characteristic of the Washington and New York trains of the Baltimore & Ohio Railroad. It has been found that this color meets all the requirements, and it is probable that in the near future the entire passenger equipment will be so painted and the B. & O. have a distinctive color for all its trains.

The Q & C Pressed Steel Brake-Shoe Key.

The Q & C Company, Western Union Building, Chicago, Ill., have recently acquired all rights to manufacture the pressed steel brake-shoe key, known as "The Drexel," and as the company has every facility for manufacturing them they will carry a large stock and will be able to supply them promptly and at low prices. The key, which is shown herewith, is much lighter than forged keys but it is very strong. It is cheaper than a forging and it conform



exactly to the Master Car Builders' standard in every respect. All the brake-shoe keys of this design are remarkably uniform in size and strength, and in addition to the economy they save the annoyance and trouble of forging such small work in the smith shop. The key is hereafter to be known as "The Q & C." Prices in large or small quantities can be had by writing to the company.

The Roberts Water-Tube Boiler.

The Roberts Safety Water Tube Boiler Company was incorporated in 1890, and notwithstanding the business depression that has existed throughout the country during several of the six years of the company's existence, its business has grown steadily and has assumed large proportions. The capital stock of the company is $250,000, and last month it declared its sixth consecutive annual dividend of 10 per cent. It has built nearly 900 boilers; ranging from those suitable for small launches up to installations of nearly 2,000 horse-power in one vessel. It is claimed that the works of this company are larger than any other plant in the United States devoted exclusively to the construction of marine water tube boilers. The tools are of the most modern type, nearly $30,000 having been expended in adding to them during the past year.

Although the Roberts Company are the owners of a number of patents on water-tube boilers, they have found that, all things being taken into consideration, the original type gives the best satisfaction, with some slight improvements in its construction and material. With the possible exception of one different type which has since been practically discarded by its manufacturer, the Roberts boiler is the father of all the marine water-tube boilers now being manufactured in this country, and it has attained an enviable reputation throughout the greater part of the civilized world. The original boiler, built by Mr. Roberts in 1879, is still in use, although it was infinitely inferior to anything built at the present day. The Roberts boilers have an excellent record for reliability also, for not one of them has ever killed a man or produced a disastrous explosion.

The Falls Hollow Staybolt.

Most of our readers are familiar with the staybolts made by the Falls Hollow Staybolt Company, of Cuyahoga Falls, O. The material employed in their manufacture is the best-hammered charcoal iron, and the company guarantees its product to be the equal if not the superior of any brand, domestic or imported, in the market. The Southern Railway recently tested some of these bolts and the following is the result obtained, which we take from a facsimile of the report:

Area in square inches.	Elastic limit per square inch.	Ult. tensile strength per square inch.	Elongation in eight inches.	Remarks.
.657	31,600	51,000	31.25%	Fracture fibrous.

The manufacturers recently received from Mr. Barnes, of the Wabash road a letter, in which an excellent tribute to the quality of these staybolts is given. The letter is as follows:

SPRINGFIELD, Ill., Nov. 4, 1896.

Falls Hollow Staybolt Company, Cuyahoga Falls, O.

GENTLEMEN: Specifications of standard Wabash engines have been recently issued, and the proposition is to be in the market for a number of these locomotives.

In these specifications I have enumerated Falls Hollow staybolts, in confidence that they are the best we can buy for the purpose intended.

I bespeak for this company the best bolt you can make. We want the same bolt which you advertise as your standard goods.

Yours truly, J. B. BARNES.
S. M. P. and M. Wabash Road.

The bolts are made in all sizes from seven-eight inch to two inches outside diameter, and from one-eight inch to three-quarter inch inside diameter, depending somewhat upon the outside diameter, though considerable of a choice in the relation between the two diameters is given in the company's list of standard sizes.

The Manufacturers' Advertising Bureau has now been some six months at its new location, 126 Liberty street, New York City, and finds the move from the old-time headquarters at "111" to have been a good one. The present facilities of the Bureau are thoroughly up-to-date, and enable it to care for the large business entrusted to its care to the utmost satisfaction of its clients and with the greatest degree of convenience and dispatch. There is no other concern in the United States quite like the Manufacturers' Advertising Bureau in the business it conducts, which is original and peculiar to itself. Established in 1879 by its present head and proprietor, Mr. Benj. R. Western, who was for some years previously a publisher of trade journals, its purpose is to manage the newspaper work and advertising for firms who have not the time, inclination or experience to conduct this department of their business themselves, and yet wish brought to it the attention it deserves. The Bureau is an authority on trade-journal advertising, to which it has confined its operations almost wholly, and those in need of expert help in this direction will do well to note the fact. A booklet with the title "Advertising for Profit" is published by the concern for gratuitous distribution to manufacturers generally who are desirous of knowing just how it works.

The new plant of the Fox Pressed Steel Company, at Pittsburg is nearing completion, and will soon be ready for operation.

It is reported that the Newport News Ship Building & Dry Dock Company will enlarge some of its shops in the near future.

The Colorado Fuel & Iron Company, Pueblo, Col., are said to have an order for 10,000 tons of steel rails from the Santa Fe Railroad.

A new Pintsch gas plant is being erected at Pittsburgh for the benefit of the B. & O. R. R., which has adopted this light for its passenger trains.

The Bass Foundry & Machine Works, Fort Wayne, Ind., is said to have closed a contract to furnish a large railway system with car wheels to the amount of over $500,000.

At the recent annual meeting of the stockholders of the Westinghouse Air Brake Company, it was shown that the gross business for the previous year amounted to $5,947,600 and that the assets are $2,607,936.

The Rand Drill Company has received orders for compound air compressors for the Great Northern and the Chicago, Rock Island & Pacific. One of their compressors was recently started in the Gladstone shops of the St. Paul & Duluth.

A large barge for the Hartford & New York Transportation Company was launched last month from the Gildersleeve shipyard, Hartford, Conn. It is 190 feet long and 31 feet beam, with a carrying capacity of 1,350 tons on a draft of 11 feet.

The Laidlaw-Dunn-Gordon Company, of Cincinnati, is building three large air compressors for the Baltimore & Ohio road, and a number of steam pumps for the same road. The company also has some good orders from the Illinois Central and the Chesapeake & Ohio roads.

The Harlan & Hollingsworth Company, of Wilminton, Del., have a contract from the Merchants & Miners' Transportation Company, of Baltimore, Md., for a steel steamer for the company's Baltimore and Boston line. The boat is to be a fine one, and of the following dimensions: Length, 293 feet; beam, 42 feet; depth, 34 feet.

The Babcock & Wilcox Company have furnished two boilers to the New Castle, Pa., Electric Railway Company. The Buckeye Engine Company, Salem, O., have built two cross compound engines of 500 horse-power each for the same plant. The Hall Steam Pump Company, of Pittsburg, have furnished the condensers.

During the last few months the Westinghouse Machine Company Pittsburg, Pa. have shipped the following compound engines abroad: To Algeria one 80 horse-power; to Belgium one 330 horse-power, and two 100 horse power; to France one 1,200 horse-power. In addition they have shipped a large number of Standard and Junior engines during the same period.

The Franklin Steel Casting Company, Franklin, Pa., manufacturers of steel casting, have added to their plant a number of buildings, tools, cranes, furnaces, etc., and they now possess one of the largest steel-casting plants in the country. This company manufactures the Lone Star steel coupler. It is prepared to make steel castings of all kinds up to 60,000 pounds weight.

A contract for 25 air compressors and 25 air receivers, of medium and small sizes, has been closed by the Clayton Air Compressor Works, Havemeyer Building, New York, with one company, delivery of the entire order to be made within six months from date. They also report sales of five air compressors of standard pattern during the first week in November, and the indications point to a decided revival of trade in air compressors many orders having been held in abeyance, pending the result of the election.

The Westinghouse Air-Brake Company has completed arrangements for the manufacture of air brakes at Hamilton, Ontario. The buildings of the McKehnie Machine Company, at Hamilton. have been purchased, and application has been made for a Canadian charter for the Westinghouee Manufacturing Company, Limited of Hamilton. The capital stock of the new concern will be $500,000 The best modern machinery will be installed in the plant. The capacity will be about 1,000 sets of air-brakes a week. The object of locating in Canada is, of course, to avoid paying duty on brakes sold in Canada, which is about 35 per cent., or nearly $14 per set of brakes. The General Manager of the new works will be George F. Evans; Secretary, Paul Myler; General Superintendent, M. E. Wallace.

Messrs. R. Ulrich and Charles W. Leavitt, Jr., announce that they have entered into co-partnership for carrying on their professional work of landscape architecture and civil engineering, the firm name being Ulrich & Leavitt. They will make a specialty of furnishing surveys, plans and estimates for developing public and private grounds, including irrigation and drainage. Mr. Ulrich has a large and varied experience, having been landscape architect and superintendent for Hotel del Monte Park, Monterey, Cal., and the public parks of Brooklyn, also for the World's Columbian Exposition at Chicago (under Messrs. Olmstead & Eliot). Besides these he has designed and laid out a number of private grounds. Mr. Leavitt has for several years been in charge of the engineering for the improvements at Essex Falls, N. J., and has also been Assistant Engineer in the East Jersey Water Company. The offices of these gentlemen are at 15 Cortlandt street, New New York City.

Judge Sage, of the United States Circuit Court for the Southern District of Ohio, last month rendered a decision in the long-drawn, out suit of W. W. Dodge *et al.* vs. Post & Company *et al.* The defendants were held to infringe two claims of a patent on wooden split pulleys, No. 260,462, granted to Dodge & Philion, which claims read as follows:

"1. A separable pulley whereof, when the meeting ends of the rim are in contact, the meeting faces of the spoke-bar and hub are slightly separated, as described, combined with clamp bolts *G*, whereby said hub is clamped upon the shaft in the manner set forth.

"3. A separable pulley whereof, when the meeting ends of the rim are in contact, the meeting faces of the spoke-bar are slightly separated, and clamp bolts *G*, combined with a separate split thimble interposed between said shaft and pulley, substantially as set forth."

The Dodge Manufacturing Company, Mishawaba, Ind., owns the patent thus sustained.

The Keystone Axle Company expects to start up a new plant for making car axles at Beaver Falls, Pa., on Jan. 1. The process is a new one, the axles being rolled instead of forged, and it is expected that the rolling process will add to the tensile strength of the material. The building, 80 by 200 feet in size, has been put up by the Pennsylvania Bridge Company. Steam will be supplied by six Brownell boilers of 1,200 horse-power. The rolls are being made by Robinson, Rae & Company, of Pittsburg, from designs furnished by J. T. Rowley, of Tyrone, Pa. The rolling process consists of first reducing blooms nine inches square to round bars 5½ inches in diameter. These are cut to the exact length of the axle and, after reheating, they pass through rolls that give them the shape of the finished axle and bring them to exact size, except at the journal and wheel seat, where one-sixteenth inch is allowed for a finish. It is said the axles will go through the shaping rolls at the rate of two per minute. The offices of the company are in the Equitable Building, Baltimore, Md. Mr. D. A. Clark is President; J. T. Rowley, Vice-President; T. R. Torrence, Secretary and Treasurer, and J. Deegan Superintendent.

Our Directory

OF OFFICIAL CHANGES IN NOVEMBER.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atlanta, Knoxville & Northern.—This is the reorganized Marietta & North Georgia Railroad, and Mr. Joseph E. McWilliams has been appointed General Manager, with headquarters at Atlanta, Ga. Mr. H. K. McHarg has been chosen President, and Mr. Eugene C. Spaulding, Vice-President.

Central Railroad of Georgia.—Mr. John M. Egan has been elected Vice-President, with headquarters at Savannah, Ga.

Chicago, Rock Island & Pacific.—Mr. Wm. H. Stocks is appointed Division Master Mechanic of the East Iowa Division, with headquarters at Rock Island, Ill.

Chicago & Southeastern.—Mr. W. De Sanno has been appointed Master Mechanic, vice Mr. J. W. Roberts, resigned.

Cincinnati, Lebanon & Northern.—Mr. Joseph Wood has been elected President, to succeed Mr. Geo. Hafer, resigned.

Huntindon and Broad Top Mountain.—William W. Noble has been appointed Purchasing Agent and Paymaster, vice S. B. Knight, resigned.

Middle Tennessee & Alabama.—Mr. Gaunt Crebs has been appointed Receiver.

New England.—Mr. J. T. Odell has resigned the position of Second Vice-President.

New Orleans & Western.—Mr. W. W. Tomlinson has been appointed Chief Engineer, with headquarters at New Orleans, vice Mr. C. B. Deason, resigned.

Northern Pacific.—Mr. Geo. C. Gorham has been elected Vice-President.

Pennsylvania Lines.—Mr. Bernard Fitzpatrick, Master Mechanic at Columbus, has been appointed Master Mechanic at Fort Wayne, to succeed W. W. Atterbury. Mr. Thomas F. Butler is transferred from Wellsville, O., to Columbus, O, to succeed Mr. Fitzpatrick. Mr. Geo. P. Sweeley is transferred from Crestline, O., to Wellsville, and Mr. P. F. Smith, Jr., Assistant Master Mechanic at the Fort Wayne shops, is promoted to the position of Master Mechanic at Crestline, O.

Philadelphia & Reading.—Mr. Joseph S. Haniss has been chosen Vice-President, and Wm. R. Taylor, Secretary.

Quincy, Omaha & Kansas City.—Mr. O. H. Spencer has been appointed Assistant General Manager and is in charge of the purchasing of supplies.

Southwestern.—Mr. B. A. Denmark has been elected President, to succeed the late Mr. Baxter.

Tabor & Northern.—H. T. Woods has been elected General Manager.

Vandalia.—Mr. Volney T. Malott, of Indianapolis, has been appointed Receiver.